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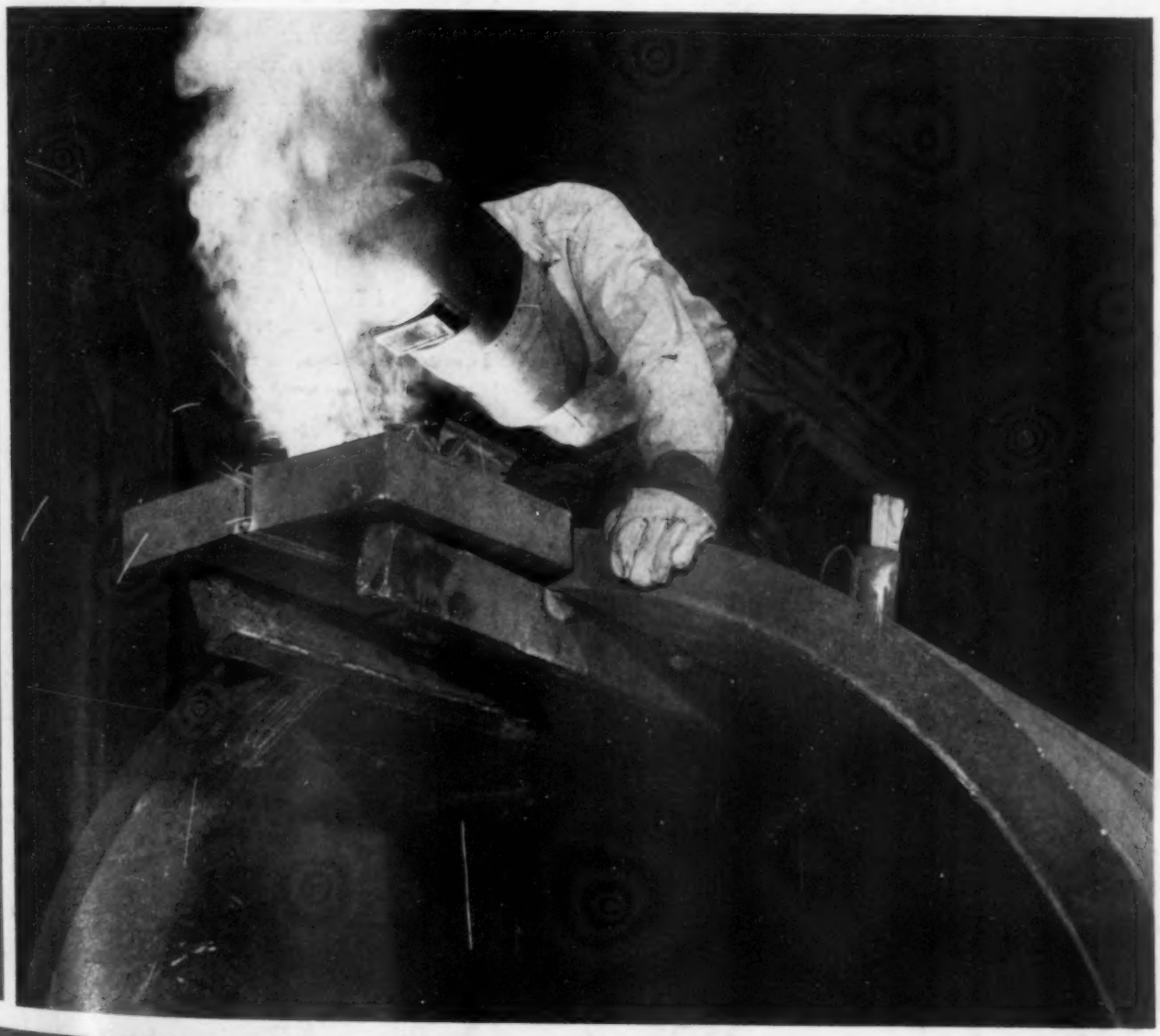

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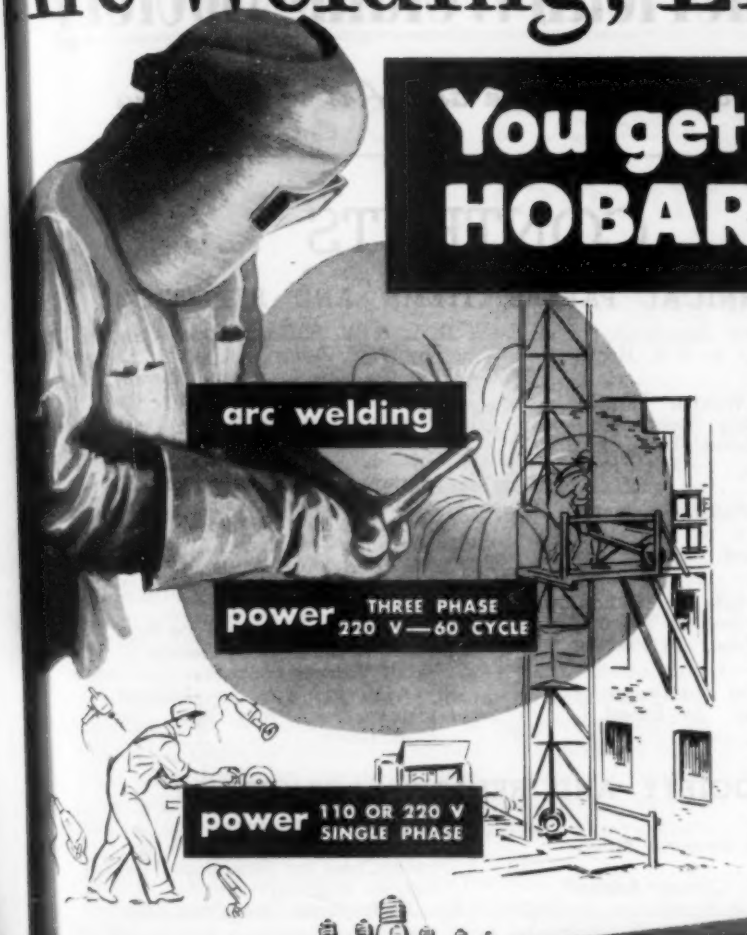

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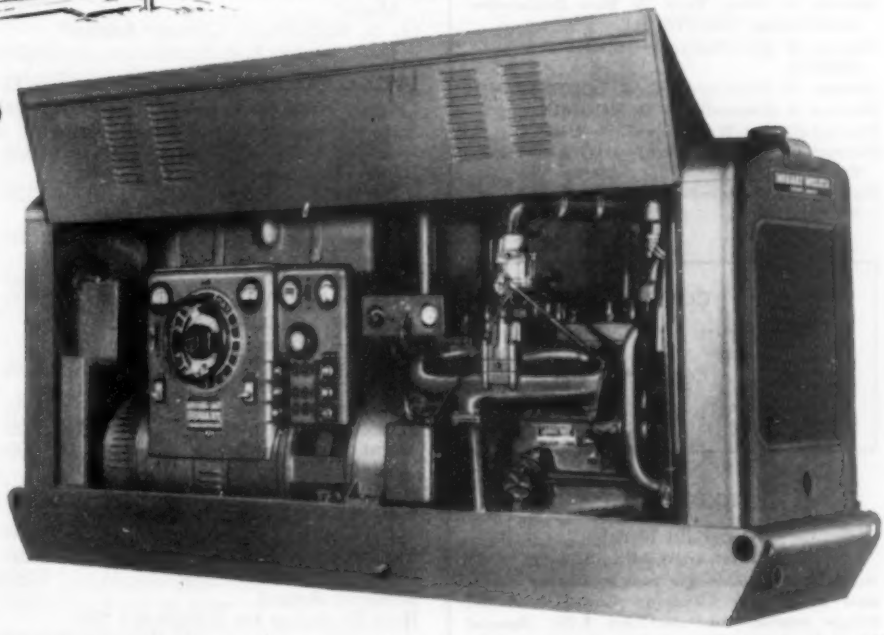

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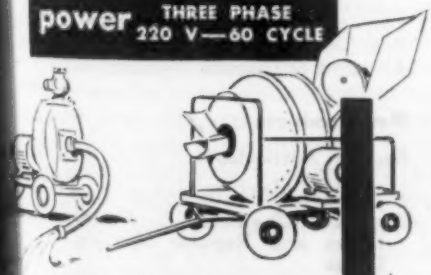

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Published for the Advancement of the Science and Art of Welding

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COVER

High-pressure steam boiler drum being welded. Test plate shown on end of drum. (Scene from G-E motion picture "Arc Welding at Work.")

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Subscriptions $5.00 per year in United States and possessions; Foreign Countries $7.00. Single copies, non-members $.75; Special issue October $1.00; members 50 cents.

Entered as second-class matter January 15, 1932, at the post-office at Easton, Pa., under the act of March 3, 1879.

PUBLICATION OFFICE
20th & Northampton Streets, Easton, Pa.
EDITORIAL AND GENERAL OFFICES
33 West 39th St., New York 18, N. Y.

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The Journal of
The American Welding Society
VOLUME 26 · NUMBER 11 · NOVEMBER 1947

Precision Pressure Regulation of Various Gases*

By J. K. Hamilton†

Introduction

DURING the past decade the scope of industrial processes involving oxygen and acetylene or some other fuel gas has multiplied many fold. The modern welding engineer finds that he is expected to be familiar, at least to some degree, with cutting, scarfing, descaling, hand and machine welding, flame treating, and various forms of pressure welding in addition to the electric processes. During the time when the newer processes were passing through the development stage, and even after they were considered standard procedure, there has been little advance in the art of pressure control as applied to these processes. Dozens, and perhaps hundreds, of patents on various phases of pressure control have been issued during this period, but little physical development has been carried on that has led to production models available for general use.

There are at least two reasons for this situation: In the first place, pressure-control equipment is an auxiliary to the actual process equipment and consequently has been relegated to a position of secondary importance; a sort of necessary evil whose importance is not recognized until the process is fairly well along and trouble develops that can be definitely attributed to inferior control of pressure.

Secondly, during the war period there was a priority demand for pressure-control instruments outside of the oxyacetylene industry, a demand that claimed the services of many engineers who normally spent their time on oxyacetylene-control equipment.

The cutting and scarfing processes usually do not require precise pressure regulation and in fact, up until about 1940, the only processes that demanded special attention were those involving flames of closely defined gas ratio such as the so-called "back hand" welding process, tube welding or welding of aircraft tubing. Even in these cases a reasonable frequency of manual readjustment could be tolerated. Since that time the number of processes involving a closely maintained gas ratio has greatly increased and semiautomatic processes have been introduced making it essential that the necessity for frequent manual adjustment be eliminated.

Figure 1 is schematically illustrative of an oxy-fuel gas process. The heart of the process is the burner which may be used for heating, cutting, scarfing, etc. Other items that are essential are the machine for mounting the burner, holding the workpiece being processed, or moving the burner relative to the work, the auxiliary-control equipment which may be electrical, hydraulic, or pneumatic, and the gas-control equipment. The entire equipment when considered as a whole gives certain mechanical and metallurgical results known as the process. It is with the gas-control problem that this paper will be concerned.

Purpose

Briefly stated, the purpose of this paper is to emphasize the importance of the pressure-control phase of an oxy-fuel gas process and to discuss some of the basic considerations leading to an adequate definition of requirements and detailed design of suitable equipment to meet these requirements. A secondary purpose is to acquaint the welding engineer with some of the problems encountered by the pressure-control engineer when he is confronted with a specification reading: "The pressure must be held as close as possible with no change in the gas ratio."

Method of Attack

In order to accomplish the purpose, four things will be done and in this order:

1. The effect of a variation in the burner-supply pressure on the basic process variables will be developed mathematically. This will serve to indicate how the basic requirements of the pressure-control equipment are arrived at.
2. The basic mathematics involved in pressure-regulator design will be presented. The resulting equations or variations of them are used regardless of the type of regulator under consideration.

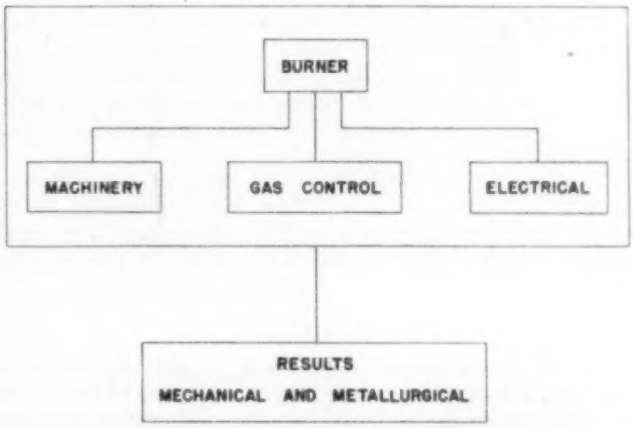

Fig. 1—Oxy-Fuel Gas Process

* Presented at the Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

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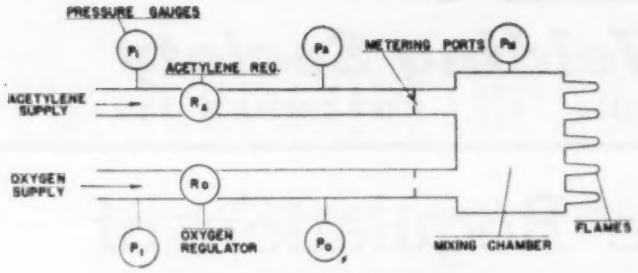


Fig. 2—Schematic of Apparatus

3. Some basic types of regulators will be discussed and means for making them conform to precise standards will be indicated.
4. Some of the more common problems associated with regulator design will be covered.

Since the design procedure is independent of the type of process and dependent only upon the performance specifications, it will be assumed throughout this paper that the apparatus involved is similar to that shown schematically in Fig. 2. This may represent the gas equipment for a flame-hardening, pressure-welding, or similar process.

It will further be assumed that the gas ratio is approximately one and that positive-pressure-burner mixers are involved. The gases will be oxygen and acetylene supplied to the equipment by way of shop pipe lines. The following nomenclature will be used:

Q = rate of gas flow, cfh
dQ = change in rate of gas flow, cfh
P = pressure, psi
dP = change in pressure, psi
P_o = Oxygen pressure at burner inlet, psi
P_a = acetylene pressure at burner inlet, psi
P_1 = regulator inlet pressure, psi
P_2 = regulator delivery pressure, psi
P_m = burner mixing chamber pressure, psi
Q_o = rate of oxygen flow, cfh
Q_a = rate of acetylene flow, cfh
Q_m = rate of flow of mixed gas, cfh
K = constant
R = gas ratio, oxygen to acetylene
dR = per cent change in gas ratio
A_1 = effective seat area, sq. in.
A_2 = effective diaphragm area, sq. in.
D = effective seat diameter, in.
S = seat displacement, in.
dS = change in seat displacement, in.
Δ = total stiffness in system, lb. per inch

Effect of Burner-Supply Pressure on Process Variables

For our purpose, the process variables are two in number; i.e., the total heat input and the gas ratio. The heat input is obviously the product of the rate of flow and time. Since the timing mechanism is outside the scope of this paper, the time element will be ignored leaving simply rate of flow and gas ratio.

To simplify the analysis of the effect of a variation in supply pressure on rate of flow let us consider that a single gas is discharging into the atmosphere through a simple orifice. The simplified equation for flow is given by:

$$Q = K\sqrt{P} \qquad (1)$$

where K is a constant depending on the discharge coefficient, gas density, temperature, and area of the orifice. By differentiating and making the proper substitutions it can be shown that for a given basic inlet pressure the per cent change in rate of flow is equal to a constant multiplied by the actual change in inlet pressure expressed in pounds per square inch. Figure 3 is a plot of this relationship. An example of the use of this curve is as follows:

The base supply pressure is 10 psi. The corresponding value of the constant is 5. Thus, if the inlet pressure varies by 0.1 psi, there will be a corresponding change in rate of flow of $^1/_2\%$. This relationship can be applied to the system shown on Fig. 2 in which P is replaced by P_o or P_a and Q by Q_m without the introduction of much error. In fact, the relationship fails on the safe side. For our purpose it is satisfactory to use it to indicate the change in rate of flow or heat input for a given variation in supply pressure.

From the example given, a 0.1 psi variation in supply pressure results in a 0.5% change in heat input which is usually more than adequate, especially since it will be brought out in the following paragraphs that much more precise pressure regulation is required from the standpoint of the other process variable; i.e., the gas ratio. In order to determine the effect of supply pressure on gas ratio, it is necessary to develop the differential equation expressing the relationship of variables for the typical gas supply system as shown in Fig. 2. The equation for oxygen flow through the oxygen metering port of the burner is as follows:

$$Q_o = K_o\sqrt{(P_o - P_m)\,(P_m + 14.7)} \qquad (2)$$

By setting up a similar equation for the acetylene metering port and using the definition of gas ratio; i.e.,

$$R = Q_o/Q_a \qquad (3)$$

The equation for gas ratio is given by the expression:

$$R = \frac{K_o}{K_a}\sqrt{\frac{P_o - P_m}{P_a - P_m}} \qquad (4)$$

By making use of the fact that the total flow of the mixture, Q_m, is equal to the sum of the acetylene and oxygen flows and that the mixture discharge rate through the burner exit ports is expressed by a relation similar to Equation 1, Equation 4 can be differentiated resulting in the expression:

$$dR = 50\,\frac{K_o}{K_a}\left[\frac{dP_o}{\sqrt{(P_a - P_m)\,(P_o - P_m)}} - \frac{dP_a\sqrt{P_o - P_m}}{(P_a - P_m)^{3}/_{2}}\right] \qquad (5)$$

plus some additional terms taking into account the vari-

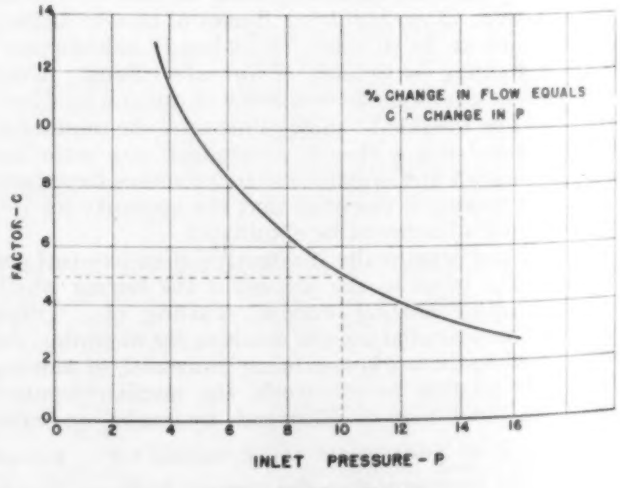


Fig. 3—Flow Factor

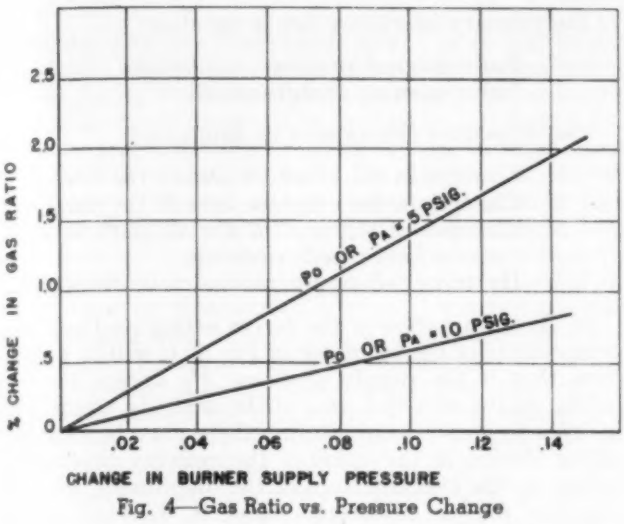


Fig. 4—Gas Ratio vs. Pressure Change

ation in gas ratio due to the variation in mixer pressure, P_m. These additional terms may safely be neglected since they represent only about 2% of the total change in gas ratio.

With a substitution of the proper values for K, Equation 5 can be used to determine the per cent change in gas ratio for any change in oxygen or acetylene pressure regardless of the basic values of the pressure (so long as they are less than about 15 psi) and whether or not the basic pressures are equal or different.

Figure 4 represents a plot of this relationship for two basic values of pressure; i.e., 5 and 10 psi. An example of the use of these curves is as follows:

Assume that the acetylene pressure is 5 psi and that the oxygen pressure is 10 psi. If the gas ratio is originally unity and there is an increase in acetylene pressure of 0.04 psi and a decrease in oxygen pressure of 0.06 psi occurring at the same time, there will be a decrease in gas ratio of about 0.55% due to the change in acetylene pressure and a decrease in ratio of 0.30% due to the change in oxygen pressure. This results in a net decrease in gas ratio of about 0.85%. If only the acetylene pressure varied, the gas ratio would decrease only 0.55%.

The preceding paragraphs, dealing with the variation in gas ratio resulting from a specific change in burner supply pressure, are obviously of little use unless something is known about the effect of gas ratio on the process as a whole. Therefore, the next logical step is a brief analysis of the actual effect on the process of a varying gas ratio. It is well known that a change in gas ratio is effective in at least three different ways:

1. Effect of a varying flame temperature.

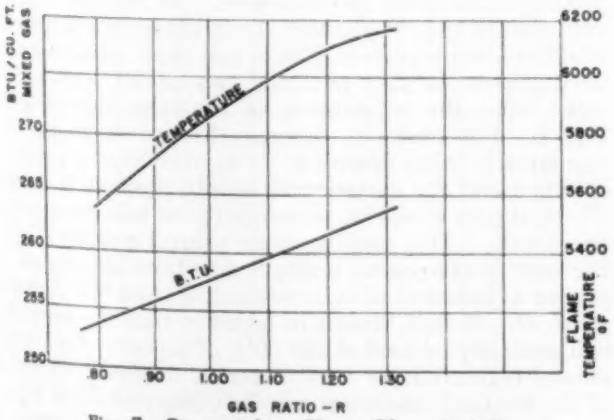


Fig. 5—Oxyacetylene Flame Characteristics

2. Effect on the heat liberated per cubic foot of mixed gas used.
3. Metallurgical effect of the excess carbon or oxygen.

Figure 5 includes a curve illustrating the computed variation in flame temperature of the inner cone of an oxyacetylene flame with a change in gas ratio. For a ratio in the region under discussion, it will be noted that the temperature varies about one quarter of 1% for a 1% change in gas ratio.

Also included in Fig. 5 is a curve showing the heat liberated in the primary combustion of acetylene and oxygen for different gas ratios. In this case, the variation in heat liberated per cubic foot of mixed gas is less than one-tenth of 1% for each 1% variation in ratio.

In attempting to deal with the third item listed above, i.e., the metallurgical effect, a rather complex situation arises in that it is impossible to mathematically assay the effect of gas ratio. Here it is necessary to fall back on experimental data and previous process experience. The experimental results, as far as gas ratio is concerned, are usually found to be on the inconclusive side when closely scrutinized since the pressure-control engineer

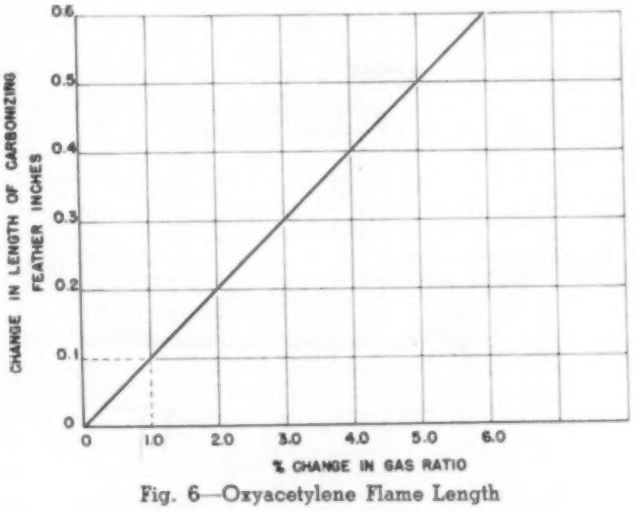


Fig. 6—Oxyacetylene Flame Length

knows that, even with the best laboratory equipment, it is extremely difficult to measure a rate of gas flow to a precision greater than about one-half of 1%. Since two gases are involved, the possible error in gas ratio may be 1%. With the very best commercial meters now available, the possible error in measuring gas ratio with production line equipment is probably in the order of 3%.

Because of this metering situation, it seems logical that the best way out of the difficulty is to compare metallurgical results with the length of the carburizing feather present on the oxyacetylene flame. Figure 6 is a curve illustrating the relationship between gas ratio and feather length for one type of single-hole burner using precise laboratory flowmeters to obtain the data. From this curve it will be noted that a 1% change in gas ratio results in a 0.10 in. change in the length of the carburizing feather which is very easily noted by eye. This method cannot be used when oxidizing flames are involved but it seems probable that, if the allowable change in gas ratio is determined using such a curve and translated to a corresponding allowable change in supply pressure, little error will be involved providing the gas ratio is in the general region of one.

Summary of Requirements

Under the section titled "Purpose," it was stated that

the welding engineer has a habit of specifying that the pressures must be maintained so that "there is no noticeable change in gas ratio." It has been the purpose of the previous section to indicate just what this involves. It was finally concluded that a 0.1 in. change in length of a carburizing feather was equivalent to a 1% change in gas ratio. Let us see what appears to be reasonable interpretation of the specification and assume that the 0.1 in. change is allowable. This means that the change in gas ratio resulting from variations in each gas supply pressure is in the order of one-half of 1%. From Fig. 4 this corresponds to a deviation in supply pressure of about 0.035 psi if the basic pressure is assumed to be about 5 psi.

Thus a sensitive pressure regulator will maintain a flowing delivery pressure to within ±0.035 psi regardless of any variations in supply pressure or variations of flow within the normal working range of the regulator and will continue to do so with repeated "on-off" operation, hour after hour, without any manual readjustments.

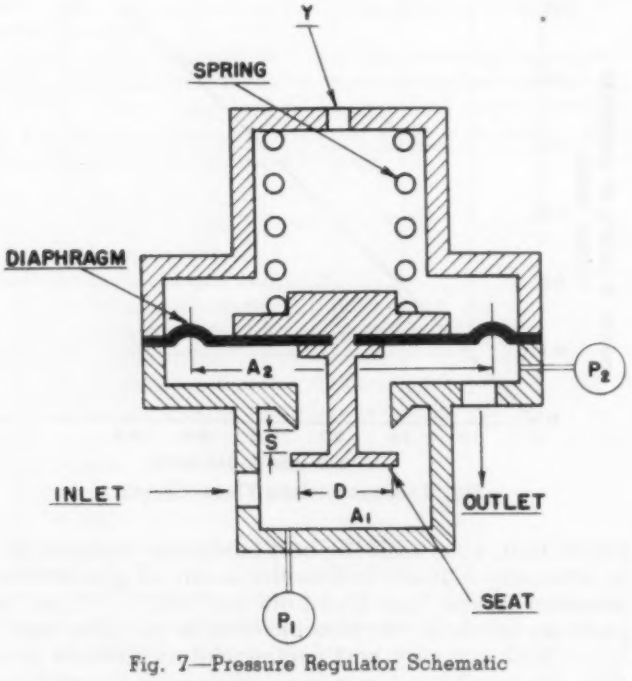


Fig. 7—Pressure Regulator Schematic

Fundamentals of Pressure Regulation

The basic essentials of a pressure regulator are a valve element consisting of a nozzle and mating seat, pressure-responsive means for controlling the opening of the valve, and a method for loading the pressure-responsive means, such as a spring. Figure 7 represents a simple regulator of this type. The inlet pressure, P_1, acts on a portion of the seat tending to close it against the nozzle lip. The spring is under compression and holds the valve open until sufficient gas pressure has developed under the diaphragm to overcome the thrust of the spring. This allows the seat to close or throttle the opening as gas is being withdrawn from the outlet side of the regulator. Although there are almost limitless variations of this simple design, it will serve the illustrative purpose for which it is intended.

The causes of a variation in the regulator delivery pressure can be separated conveniently into primary and secondary effects.

The primary effects are two in number:

1. Fundamental pressure regulation.
2. Valve opening or stiffness effect.

The secondary effects may be listed as:

1. Changes in the effective area of the seat.
2. Changes in the effective area of the diaphragm.
3. Changes in stiffness of the diaphragm with a variation in valve opening.
4. Hysteresis effect due to friction of moving parts.

In an examination of the forces acting on the various components of the regulator of Fig. 7, it will be noted at once that if the supply pressure, P_1, varies, the force acting on the effective area of the seat, A_1, changes and in order to preserve equilibrium there must be a compensating change in the value of the delivery pressure, P_2, acting on the effective area of the diaphragm, A_2. The equation for the resulting change in delivery pressure may be expressed as follows:

$$dP_2 = -\frac{A_1}{A_2} \times dP_1 \qquad (6)$$

The negative sign indicates that, with a falling supply pressure there is an increase in delivery pressure.

The second primary effect listed above takes into account the stiffness effect of any springs and diaphragms in the regulator. When the demand for gas increases or decreases or when the supply pressure changes, the valve opening must change to provide the required throttling area. In order for the valve to move, the springs must extend or compress and the diaphragm must move up or down. This results in a different total gas thrust underneath the diaphragm. Obviously in our simple regulator the only means of obtaining this change in thrust is to change the regulator delivery pressure. The effective stiffness is the sum of the various spring rates and the rate of the diaphragm. The change in delivery pressure due to this stiffness effect can be expressed as follows:

$$dP_2 = \frac{\Delta dS}{A_2} \qquad (7)$$

In order to use this equation it is necessary to have the relationship between the valve opening or seat displacement, the diameter of the nozzle, rate of flow, and pressure. Using the simplified equation for rate of flow through an orifice, the following expression may be derived:

$$Q = KDS\sqrt{P_2(P_1 - P_2)} \qquad (8)$$

In considering the primary effects it will be noted that if the rate of flow is constant and the supply pressure varies, both effects are evident. If the rate of flow varies and the supply pressure remains constant only the second primary effect need be considered. In the case where a variation in the rate of flow is not encountered, and the usual welding regulator falls in this class, advantage can be taken of the fact that the two effects oppose each other when the regulator is of the type illustrated by Fig. 6. For example, assume that an acetylene line regulator is being designed. The maximum capacity is specified and the variation in supply pressure is known. The first step would be to compute the minimum size of the nozzle. This may be done using Equation 8 after the seat displacement term, S, has been eliminated by proper adjustment of the constant, K, and the diameter term, D. If it is known in advance that the regulator will generally be used at say 50% of capacity, the fundamental regulation for various nozzle diameters in excess of the required minimum may be computed using Equation 6. To do so it is simply necessary to assume a

reasonable effective diaphragm area. More will be said later about this area. On the basis of the assumed area and the desired maximum operating pressure, a reasonable value of spring stiffness can be arrived at. It is then possible by using Equation 7 to compute the stiffness effect.

Figure 8 is a relative plot of the variation in delivery pressure for different nozzle diameters resulting from both fundamental regulation and stiffness effect. An inspection of Equations 6 and 7 will indicate that the delivery pressure varies directly with the square of the nozzle diameter in Equation 6, whereas it varies inversely with the diameter in Equation 7. This indicates that from the fundamental regulation standpoint the nozzle should be as small as possible and that from the stiffness standpoint the nozzle should be large. In the case of the regulator now being considered as an example and whose characteristics are plotted on Fig. 8, it will be noted that the two opposing effects are equal at a nozzle diameter of 0.34 in. If the regulator were always used at the assumed rate of flow or near it, the variation in delivery pressure would be negligible. A point of interest exhibits itself here when it is realized that in this single ideal case the performance of the regulator is independent of the effective diaphragm area.

If the gas demand on this regulator varies and the supply pressure is held constant, the change in delivery pressure will be substantially as shown on the third curve of Fig. 8. The regulator performance in this respect is obviously grossly inferior to that resulting from a constant demand. However, it appears only as an exaggerated change in pressure between flowing and static conditions. It is conveniently called flow-regulation.

So far in our discussion of regulators only the inverse type, shown schematically in Fig. 7, has been mentioned. This type is characterized by the fact that the supply pressure tends to close the seat against the nozzle. The second type is called "direct acting" in that the supply pressure tends to open the seat. With the direct type the fundamental regulation as given by Equation 6 is positive so that it is added to the stiffness effect to obtain the net pressure regulation. It would appear offhand that, because of this, the inverse type is basically superior. This is not always the case because, in the first place, the inverse regulator nozzle must be made larger to allow for the thrust pin between the seat and the diaphragm. The larger nozzle diameter results in a larger

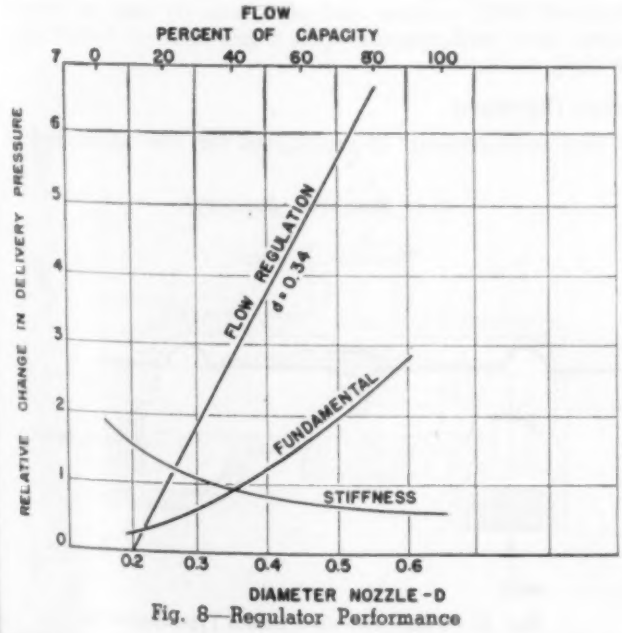


Fig. 8—Regulator Performance

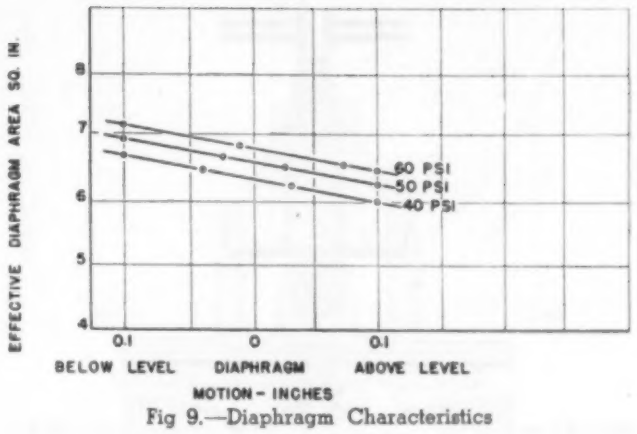


Fig 9.—Diaphragm Characteristics

fundamental regulation factor. In the second place, some regulators, particularly those for cylinder or manifold service, are not subject to a large stiffness effect since the very high inlet pressure results in seat displacements that are very small. In general, it will be found that, if spring-loaded regulators are being considered, the direct-type regulator serves best for use with very high supply pressures and that the inverse type gives better performance at low inlet pressures.

A regulator for a type of service where the requirements do not call for extreme sensitivity can usually be designed with reference only to the two primary effects. When very close regulation of pressure is essential, it is necessary to devote considerable time to a study of the various secondary effects.

The first item under this heading was listed as being caused by changes in the effective area of the seat. It is quite obvious that when the seat is very close to the nozzle lip, the area on which the supply pressure acts is greater than when heavier rates of flow are involved with their consequent greater seat displacements. Thus, if a variable flow or a relatively large change in supply pressure is involved, the resulting change in seat displacement results in an appreciable change in seat area, A_1. This means that instead of dealing with a constant value of area in Equation 6, it is a function of the seat displacement, S, in Equation 8. The variation in effective area with seat displacement cannot be computed by any rational means known to the author so must be determined experimentally. Under extreme conditions this area may vary by 40 or 50% but by limiting the maximum displacement to a value of say one-tenth of the effective nozzle diameter it can be held much lower than these figures.

The second and third secondary items involve the variable effective area and stiffness of the diaphragm. If the motion of the diaphragm can be kept small relative to its effective diameter, the change in stiffness and area can also be kept small. To do this, however, quite often results in a considerable sacrifice in bulk of the regulator and, if the regulator is of the spring-loaded type, the large diaphragm necessitates the use of a powerful and consequently stiffer spring. This usually results in complications when considering the stiffness effect. Figure 9 is a plot of data that were gathered in a study of a regulator diaphragm. It will be noted that the effective area is a function of both pressure loading and position. From the data on these curves it is possible to express the variation in terms of area or stiffness change, whichever is more convenient for the engineer to use in a specific case.

The fourth and final secondary effect is that resulting from friction. This has probably resulted in more perspiration than any other single item confronting the con-

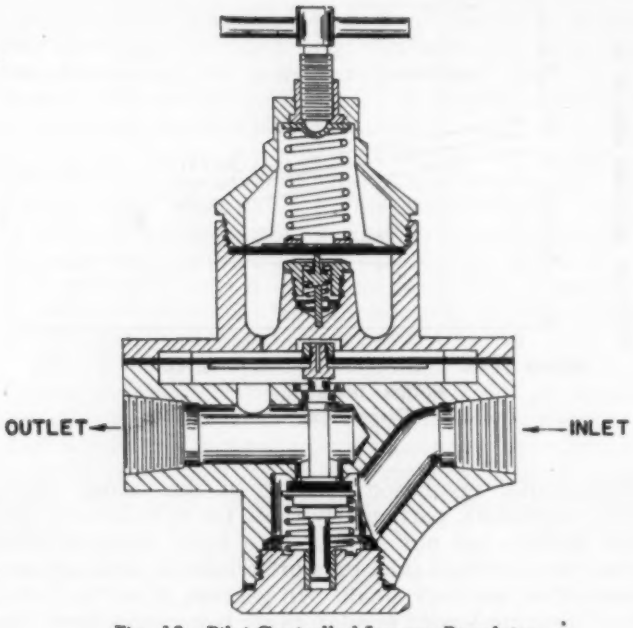


Fig. 10—Pilot-Controlled Inverse Regulator

trol engineer. In innumerable cases a regulator that is engineered correctly in all known phases fails to quite meet the specifications at all times because of this sometimes intangible friction factor. The solution usually lies in infinite patience in tracking down and eliminating the source of the friction. In many cases the only solution is a radical increase in the effective diaphragm area which means that the friction is not eliminated but its effect is rendered proportionally smaller.

Hunting

No discussion of regulator design is complete without some reference to the hunting or chattering problems. It is of particular importance when considering the design of sensitive regulators. If an all-out attack is made to furnish a regulator with very low frictional and precise operating characteristics, the result is apt to be a design that will result in hunting. If the hunting is of a very high frequency, near the inaudible range, no damage will be done either to the regulator or to the process. The usual system, however, chatters at a relatively low frequency and this results in a fluctuating flame and in eventual destruction of the metering portion of the regulator.

At the present time there are at least three more or less well-known methods of providing damping. These are:

1. Frictional damping.
2. Fluid damping.
3. Phase displacement damping.

Frictional damping has been employed as far back as pressure regulators have been in use. With this method, the engineer provides a design as free from friction as the specifications warrant and then purposely introduces a fixed amount of friction to just overcome the hunting tendency. For many regulators this method is adequate.

If damping without friction, or a greater degree of damping is required as is generally the case with rather large fixed installations operating from high initial pressures, some form of fluid damping may be suitable. In this method, either a gas cylinder with a closely fitted piston having a large travel and high compression ratio or liquid damping using some form of dashpot may be used. Either method is usually preferable to friction damping if sensitivity is a factor and the nuisance of a liquid dashpot can be tolerated.

The phase-displacement method of damping is accomplished by the use of a system whereby the response to a change in delivery pressure lags sufficiently behind the change to result in a correction out of step with the natural frequency of the moving regulator parts.

Since the requirements of oxyacetylene pressure regulators are becoming stricter it is anticipated that more attention will be given this hunting problem in the very near future.

Miscellaneous Problems

In progressing to the final design to fulfill a specific performance specification, there are many problems associated with the basic effects covered so far. Some of these will now be briefly considered.

Elimination of One Primary Effect

If a regulator is designed such that one of the primary causes of a pressure disturbance is eliminated, the over-all design may be greatly simplified. For example, to eliminate the stiffness effect it is simply necessary to substitute gas loading for spring loading. In this way the nozzle diameter can be made to the minimum size necessary to discharge gas at the maximum rate under the most unfavorable pressure conditions. If the resulting diaphragm area is too large, a multiplying lever may be introduced between the seat element and the diaphragm to reduce the area requirement to a tolerable value. Figure 10 illustrates an inverse design in which this method (less lever) has been used. The loading gas is furnished by way of a "built-in" pilot regulator which works directly off the main supply line.

Figure 11 is a direct-type regulator using gas loading and a multiplying lever. The pilot regulator (not shown) is remotely positioned and may or may not be operated by the main-supply-line gas. With the direct type, the pilot-delivery pressure is less than the master-regulator-delivery pressure so must be bled to the atmosphere at a very low rate.

Experimental units, patterned after the regulator shown in Fig. 11, have been constructed that maintain the delivered pressure constant to within 0.015 psi regardless of changes in the supply pressure or rate of outflow and with repeated "on-off" operation. A burner supplied with oxygen and acetylene by way of two of these units will operate with a gas ratio of better than $\pm 1/2\%$.

Static Increment

One requirement of regulators for the oxyacetylene

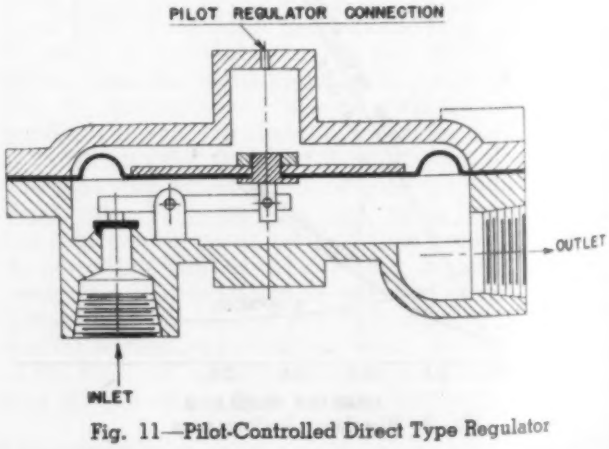


Fig. 11—Pilot-Controlled Direct Type Regulator

industry that gives the designer considerable trouble results from the fact that no seat leakage is permitted when the valve is closed. Such a leak would cause an increase in line pressure and eventually result in the loss of gases and create a hazard by allowing oxygen or fuel gases to escape to the atmosphere.

In order to move the seat from an open position to the fully closed position, some source of power is required and the only source is an increase in delivery pressure. This increase is called the static increment.

Figure 12 illustrates the two phases of seat closing. Assume that the regulator is delivering at capacity and that the demand for gas ceases. The pressure underneath the diaphragm increases bringing the seat into contact with the nozzle lip. The actual force required up to this point is F_1 on the curve. There is just a bare leak past the nozzle lip at this stage and the change in delivery pressure is equal to F_1 divided by the effective diaphragm area. Incidentally this change in pressure is equal to the flow-regulation of the regulator. If the plane of the contact between the seat and the lip were optically flat there would be no leakage. Actually this ideal condition cannot be attained so it is the usual practice to use a relatively soft and yielding seat material to care for any irregularities. In order to eliminate this small leak, it is necessary to stress this material to a unit value in excess of the gas pressure. The force to do this is made available by a further increase in delivery pressure. The force required increases rather steeply in this region since it is a function of the modulus of the seat material, the extra seat travel, and the spring stiffness. The leak is finally eliminated at some force F_2 and there is no further increase in delivery pressure. The difference between F_1 and F_2 is usually substantially greater than the value of F_1. It is the designer's problem to reduce this difference to a reasonable figure. If a very soft seat material is used, there is too much travel between seat contact and seal resulting in an exaggerated value of static increment due to the additional spring compression. If the seat is too hard, it will not accommodate minor scratches on the nozzle lip, etc., and fail to seal at any force. With gas loading the softer materials may be used providing their service life is satisfactory.

Diaphragm Materials

For extremely precise performance, it has been the author's experience that rubber or some elastomer, with or without fabric insertion, gives best results as a diaphragm material. Metal diaphragms may be used if the ratio of motion to effective area is very low. Metallic bellows are very useful in many designs but due allowance must be made for their stiffness which, with a properly selected bellows, is accurately known.

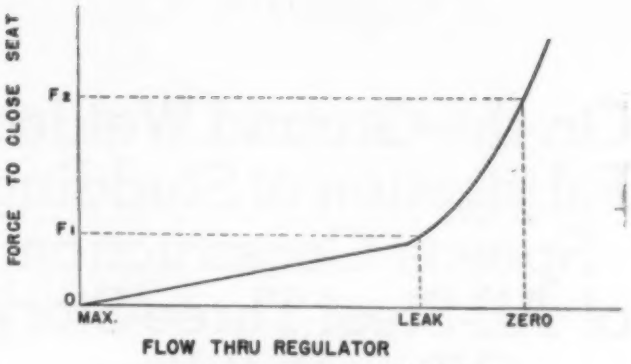


Fig. 12—Static Increment Study

Conclusion

In this paper there are numerous design problems that have not been mentioned. An attempt has been made to touch the high spots and to satisfy the avowed purpose stated earlier. Items such as chattering hydrogen regulators, freezing carbon-dioxide regulators, problems resulting from the very low permissible acetylene line pressure, safety features, etc., have been omitted because of lack of space. In conclusion it is sufficient to say that, if the expense is warranted, pressure-control instruments can be designed and built to satisfy almost any degree of sensitivity required.

Acknowledgment

The author wished to express his gratitude to Dr. Lewis Conta and John Senesky of the Airco Research Laboratory for their assistance in preparing the material for this paper.

On-the-Ground Welded Fabrication of Studding Speeds Construction of All-Steel Three-Story Office Building

By R. H. Newton*

THE headway being made by steel in the field of light-load structure building is being rapidly advanced in Houston, Tex., in the construction of a 3-story office building for the WKM Valve Co., through the use of welded on-the-ground fabrication of panels.

The contractors, The Brown Construction Co. and The Matthews Construction Co., are using Bethlehem steel studs and joists, and have reduced erection time by developing a method of prefabricating of studding in 10-ft. panels.

The Bethlehem studs are light weight, lattice-web, 1-piece members, with a minimum steel thickness of 1/8 in., as illustrated in Fig. 1. They are made from special-rolled sections by a hot-slitting, rolling and expanding process. The studs come in 3-, 4- and 6-in. widths with a 1 1/4-in. flange and cut to specified lengths. When braced laterally, the studs, it is claimed, will support a safe load of at least 6000 lb.

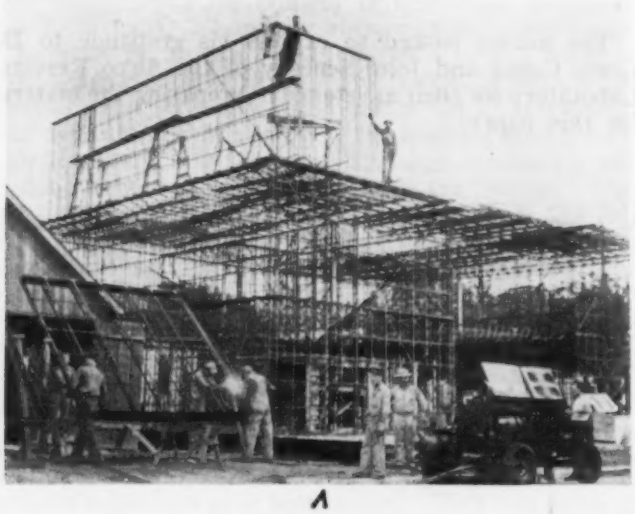
According to engineers on the job, the method of assembly being used in the WKM Valve Co. office building presents an impressive time-saving demonstration. The stretched "I" beam for light steel structure was developed before the war, but contractors tended to use it as they used individual timbers which offered no saving in time.

The panel construction method was worked out by Richard P. Matthews, head of The Matthews Construction Co. The "I" beam studs are welded in a positioning jig into 10-ft. panels on the ground. When the panel is finished it is lifted manually by four men to another crew of four men on the structure, who then place it and weld it into the framework. For the third floor, the panels are hoisted by a jig pole.

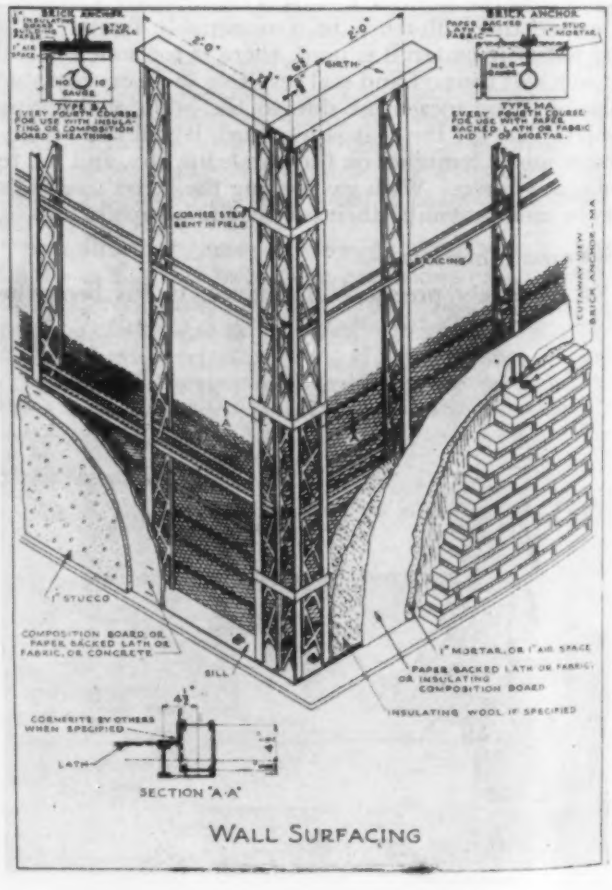
The total erection time for the steel framework was approximately 21 days, including setup preparation.

When completed, the building will be fireproof, shrinkproof, free from warpage and virtually soundproof. Another distinct advantage of this type of construction is the ease of installation of plumbing, wiring and insulation. The building will be finished with a stucco exterior and plastered and veneered interior, see Fig. 1 (*B*).

* Manager, Dealer Sales, The Lincoln Electric Co., Cleveland 1, Ohio.



A



B

Fig. 1—Only 21 Days Were Required to Erect the Steel Framework of This 3-Story, All-Steel Office Building for the WKM Valve Co. in Houston, Tex. (*A*). The Contractors, The Brown Construction Co. and the Matthews Construction Co., Using Stretched "I" Beams for Light Structures, Developed an On-the-Ground Fabrication of 10-Ft. Panels Which Were Then Hoisted and Welded in Place. As Shown in the Small Detail (*B*) the Exterior Will Be Finished with Stucco

Structural Dead Weight Eliminated in Construction of Four-Story, All-Welded Steel Building

By E. D. Anderson*

HOW to eliminate structural dead weight with resulting improvement in the load-carrying capacity of each floor is currently being demonstrated in the construction, now in progress, Fig. 1, of an all-welded, four-story building in Sedalia, Mo.

Designed by Brown's Machine Shop for their own use as an automotive machine shop, the fireproof building, which is 92 ft. by 120 ft., is being erected without a single piece of wood going into the main structure.

Additionally, the employment of the arc-welding process is making possible a lower initial construction cost and a minimum of maintenance expense is anticipated.

The basement of the building has a floor of reinforced concrete in order to permit accommodation of enormous

* Mr. Anderson is District Manager and Welding Engineer, The Lincoln Electric Co., located at 1832 Main St., Kansas City, Mo.

Fig. 1—Construction Proceeds on All-Welded Steel Building in Sedalia, Mo.

Fig. 2—Every Steel Member of the First Floor Is Being Welded. Bar Joists Are Shown Being Welded to "I" Beams

Fig. 3—Double-Strength, Reinforced Steel Pipe Is Used to Provide Columnar Support. This Is 10-In. Pipe, with a 4-In. Pipe Inside, Both of Which Are Filled with Concrete

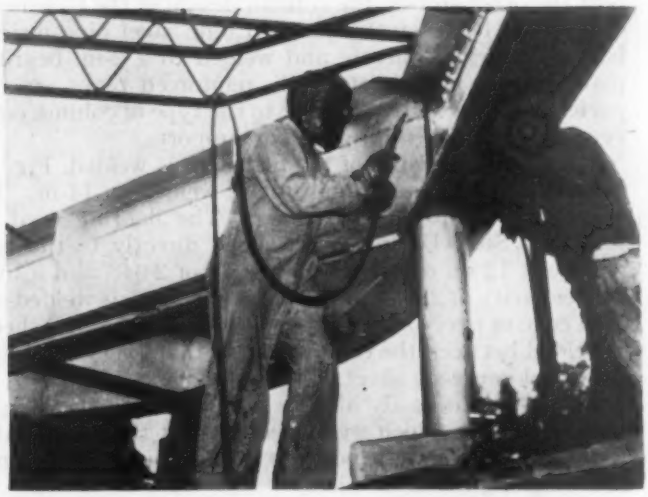


Fig. 4—Illustrative of the Welding Technique Used on All Large Members, Operators Work Directly Opposite Each Other to Equalize the Pull of Heat and Weld Metal

Fig. 5—This Curved Lintel Was Shop-Fabricated, Hoisted Into Position and Then Welded to Straight Lintels

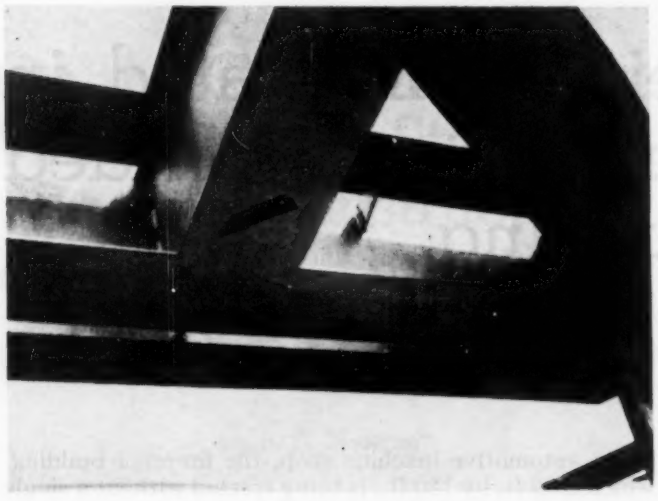
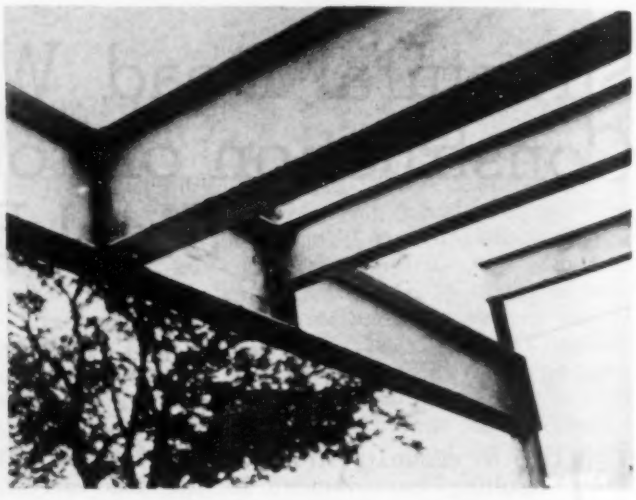


Fig. 6—These Steel Members Serve as a Unit Over Which Loading Dock Canopy May Be Welded



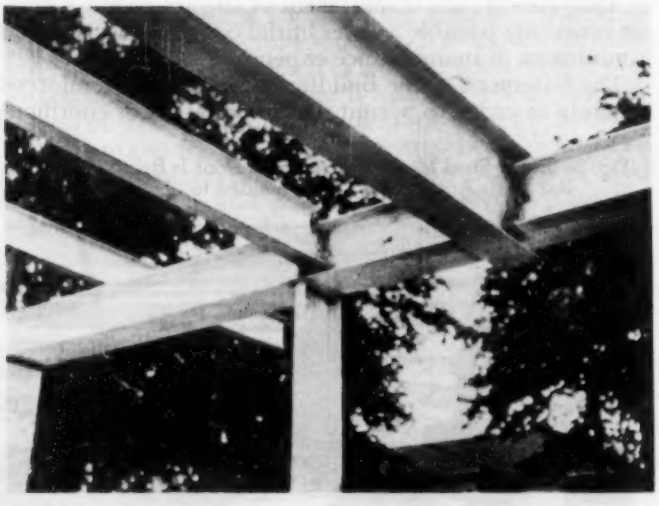


Fig. 7—Location of the Elevator Penthouse and Loading Dock. Opening Visible Between 21-In. "I" Beam and 12-In. "I" Beam Is a Stair Well Going from Second to Third Story

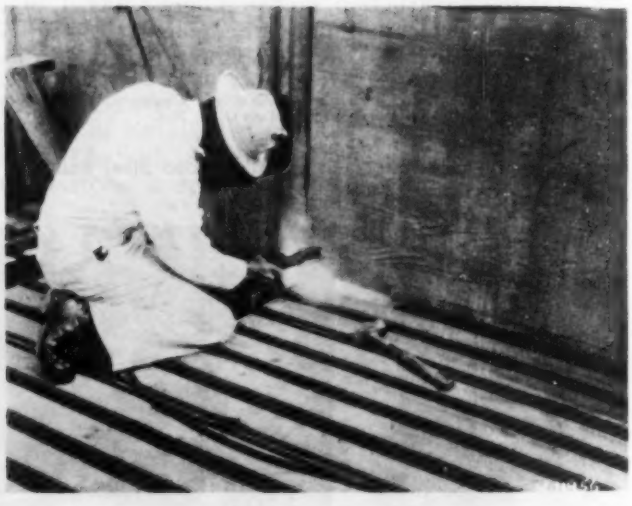


Fig. 8—Operator Is Shown Welding $3^1/_2$-In. Power Line Entrance Conduit to a Bar Joist

weight. From finished floor to finished floor, the height of the basement is 12 ft., 6 in.

To provide the strength and rigidity necessary to support the other stories, the column design in the basement consists of 10-in. steel pipe with 6-in. steel pipe inside, both filled with concrete and welded to a 2-in. bearing plate. These double strength, reinforced pipes are reported as being vastly superior to the type of column conventionally used as upright floor supports.

Every steel member of the first floor is welded, Fig. 2. First of all, Truscon bar joists are welded to 14-in. "I" beams which are $24^1/_2$ ft. long. The flooring used is Robinson Steel Deck and is welded directly to the bar joists, set 12 in. on center with span of 24 ft. and a live load capacity of 250 lb. per sq. ft. The deck is welded on each edge of every other joist and the center of the sheet is welded between the edge welds, so that every bar joist has a weld on each sheet.

The floor was easily able to accommodate the heavy truck and hoist which were used to hoist the large plate and angle girders into position, these being 40 ft. long and weighing about 40 tons.

In these welding operations, as in all other welding throughout the various phases of construction, shielded arc electrodes, A.W.S. E 6013, were used.

To provide columnar support for the second story, double strength steel pipe, smaller in diameter but similar in makeup to those used in the basement, was welded to the "I" beams (Fig. 3). These columns consist of 7-in. steel pipe, into which a 4-in. steel pipe has been inserted and both pipes are filled with concrete before being welded to 2-in. bottom plates. All of the columns used in the building are positioned by the electric hoist.

One of the major problems involved in a construction of this type is the matter of being able to hold proper alignment of the various members. This situation was overcome largely by using two welders at all times on the large beams, letting one man work directly opposite the other to equalize the pull of heat and weld metal. This technique is illustrated in Fig. 4 where a vertical weld is being made to join a curbed lintel section to a straight lintel on each end, one 80 ft. long and the other 35 ft. long—both being 24-in. lintels.

The curved lintel depicted in Fig. 5 was shop-fabricated as one solid unit and hoisted into position for welding to straight lintels that had been previously erected. The curved lintel has a 12-ft. radius and an 18-in. straight section on each end. The straight steel member (shown in the illustration) which is used to carry the floor weight has a 19-ft. span.

Another interesting application of the arc-welding process in constructing the building may be observed in Fig. 6, which shows welded steel members which serve as a unit over which the canopy for the loading dock may be welded. The largest "I" beam used in this section is a 21-in. wide flange beam and the smaller ones are 12-in. "I" beams, all of which were fabricated on the job and then welded into position.

The section of steel shown in Fig. 7 is located at the elevator penthouse and loading dock. Here 12-in. door channels formed from $^1/_4$-in. steel plate is welded to a 13-in. "Z" bar, using 6- by 6- by $^3/_8$-in. angles on the inside to complete the lintel over the loading dock door and glass block opening. The opening between the 21-in. beam and the 12-in. beam is a stair well going up to the third floor.

The conduit being welded in Fig. 8 is a $3^1/_2$-in. power line entrance conduit and is welded to a bar joist to hold it in position so that masonry work can be completed. There are also two other conduits in this entrance case, a 2-in. conduit for lights and a $1^1/_4$-in. conduit for telephone lines. The electrical outlet boxes and lines under the steel deck were welded to the bar joists before the deck was laid.

Discussion of Article on Radiography as a Control for Welding Joints in Pipe Line*

By Herbert R. Isenburger†

IT was gratifying to see that radiography has been used for the inspection of oil pipe lines which are welded in the field. While this is the first time in this country, Brandenberger (968)‡ and his associates had done similar work in Switzerland ten years ago. The writer had mentioned the possibilities as early as 1929 (254 and 365), and Dr. Ancel St. John presented a paper before the New York Section of the AMERICAN WELDING SOCIETY exactly ten years before Mr. Rhoades' paper on the same subject. At that time the writer had driven with our X-ray trailer unit from New York to Omaha, Nebr., to X-ray field welded pressure pipe in a power house which was under construction. At the time we did not have a roof over the building. It was snowing most of the time and the temperature was as low as 15° below zero. Other jobs soon followed (852) and our technique and experience, including results, have been described fully (pp. 143–150) so that we do not need to repeat them here.

* Article by Russell G. Rhoades, published in THE WELDING JOURNAL, 26 (6), 497–498 (1947).

† President, St. John X-Ray Laboratory, Califon, N. J.

‡ These numbers refer to the Bibliography in Industrial Radiology, by St. John and Isenburger, John Wiley & Sons, New York, 1943, and page and figure references in the following text also apply to this book.

Fig. 1—X-Ray Trailer Unit in Transit

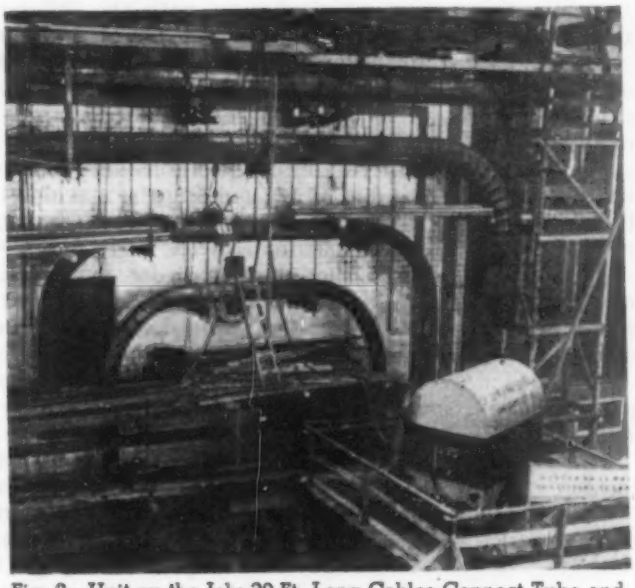


Fig. 2—Unit on the Job; 30-Ft. Long Cables Connect Tube and Transformer

However, I do want to point out the fact that there is an advantage in exposing at an angle (Fig. 66) since two exposures will disclose the location of a defect, thus facilitating repairs. By the way, with proper equipment (pp. 61–64, 885) we did not have any trouble X-raying through both walls of the pipe; we did this on diameters varying up to 24 in. While it is true that we have to penetrate double the wall thickness, our machine is powerful enough to X-ray 3 in. of steel in a 1-min. exposure.

We also had some experience with radium. The results do not compare with those obtained with X-rays. In fact they are so poor in $^1/_4$-in. walls mentioned by Mr. Rhoades, that we cannot recommend the use of gamma rays for that purpose. If X-ray inspection should not be fast enough compared to the speed of welding, it would be better to use X-rays only as an occasional check rather than to depend on something that does not give the proper results. If the welders know that their work is liable to be X-rayed, they tend to be much more careful, and satisfactory welds are usually obtained. There is no doubt that it is of great advantage to X-ray field-welded pipe joints, and it is to be hoped that more and more engineers will apply it in the future.

Building, Repairing and Design of Farm Machinery*

By Ernest J. Koop†

Building and Design of Farm Equipment

THE average welding and blacksmith shop builds some kind of a farm machine in addition to the general repair work. My welding shop does not specialize in the building of one type of machine, but leans rather to the experimental side of custom building; therefore this paper will deal more with the different types of farm equipment, their purpose, design and construction. Most all the machines built by the small shop are also built by large manufacturers, yet the small shop can and does get its share of these machines for a number of reasons.

1. The soil conditions and compositions vary a great deal in the United States, so by building the machine to fit the job is often less expensive to the farmer than to change over an existing machine.
2. When the small shop has an order for several machines of one kind, an improvement in design and structure can be made on the following machine without disrupting too many assembly line methods.
3. The large selection of welding equipment and supplies makes the small shop capable of handling most any welding job.
4. Staying in constant touch with the farmer in your locality is the best way to learn how to supply his needs.

To build this farm equipment and stay within a competitive range with other manufacturers, one must take advantage of every short cut for faster production, which demands the use of jigs and welding fixtures, yet the quantity of machines that are to be built does not allow him to make too many jigs and fixtures for a certain machine because the next machine is so different in design and purpose.

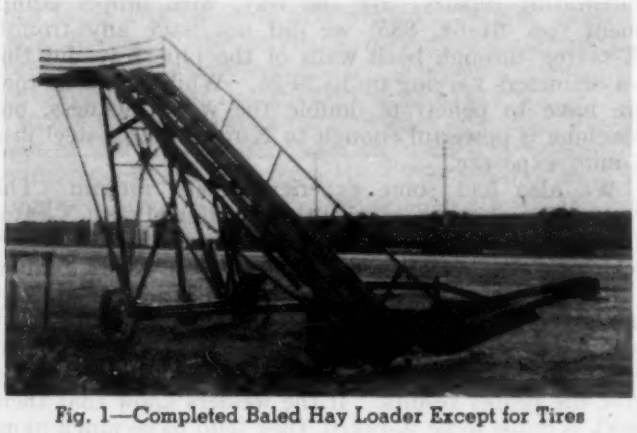


Fig. 1—Completed Baled Hay Loader Except for Tires

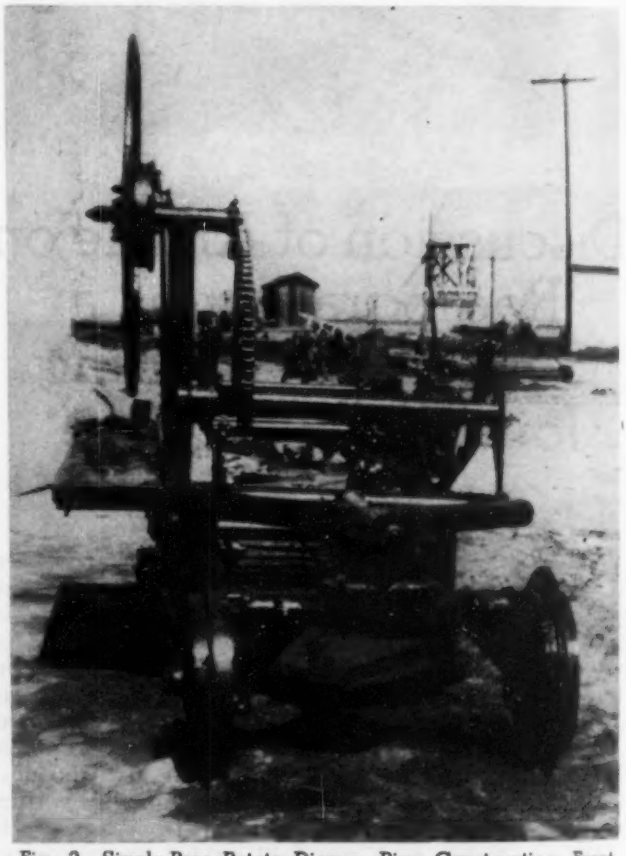


Fig. 2—Single-Row Potato Digger, Pipe Construction, Front View

The assembly rail type table of H beams such as is used in the shipyards is the answer to an all-purpose jig for the smaller shop.

Whether your project calls for tubular shapes, channels, H beams, angles, plate, etc., your assembly table will pay for itself many times over.

Certain mass production procedures can be followed even if the order is only for one machine and that machine is experimental. The main frame or foundation of your structure can be fabricated first and tack welded together. If many of the parts of a machine are to be alike, make one, do your improving on this one part, when it meets the requirements, then make all the rest. This procedure can be carried out even on the small jobs.

A semi-assembly line method is most important to the small shop operator. One man can preassemble and tack weld together one complete machine. When it is satisfactory and no more changes are to be made it is released for final welding. Intermittent and skip-around welding procedure is used to minimize welding stresses. Simplicity in design is the keynote to good farm equipment.

* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† Owner and Operator, Lakeview Welding and Blacksmith Shop, Bakersfield, Calif.

Many of the parts of the machines we build are salvaged from cars, trucks and tractors.

Figure 1 shows the baled hay loader developed by J. S. Winters and J. P. Fairbanks of the University of California College of Agriculture at Davis, Calif. A Ford rear end with driveshaft turned in a vertical up position, delivers its ground power to another Ford rear end turned in a vertical down position which drives a continuous chain in the bale chute. As the loader is pulled through the field the baled hay is picked up off the ground and elevated to any desired height. Former design of this loader had the bale skid irons mounted on a separate frame. Light shallow channel irons were made in the shop by welding $2^{3}/_{16}$ x 1 in. flat irons to a bar of $^{1}/_{8}$ x 4 in. flat. Turning the channels with the flanges down and welded onto angle iron cross braces, this design made the bale chute also serve as the frame.

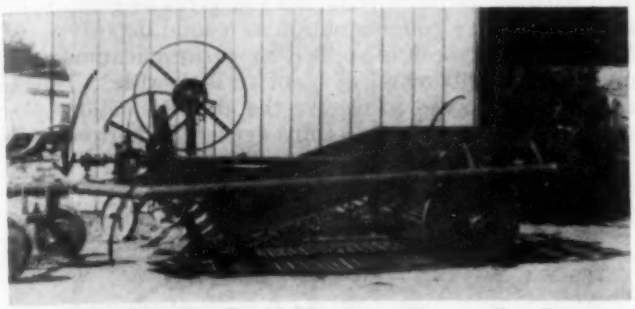


Fig. 3—Left Side View Double-Row Potato Digger, Slow Turning Joints. See Arrows

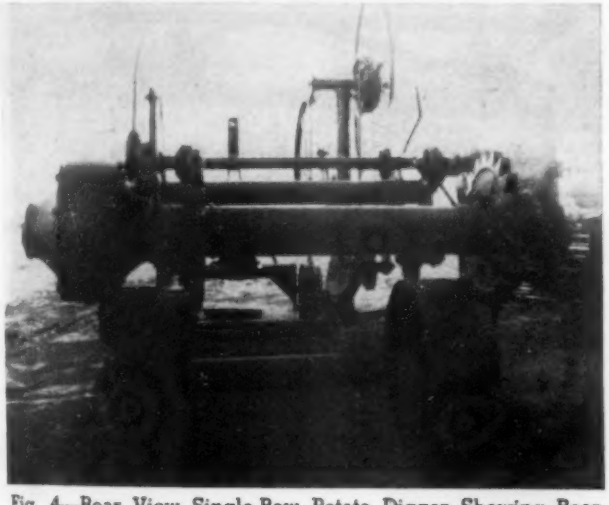


Fig. 4—Rear View Single-Row Potato Digger Showing Rear Drive

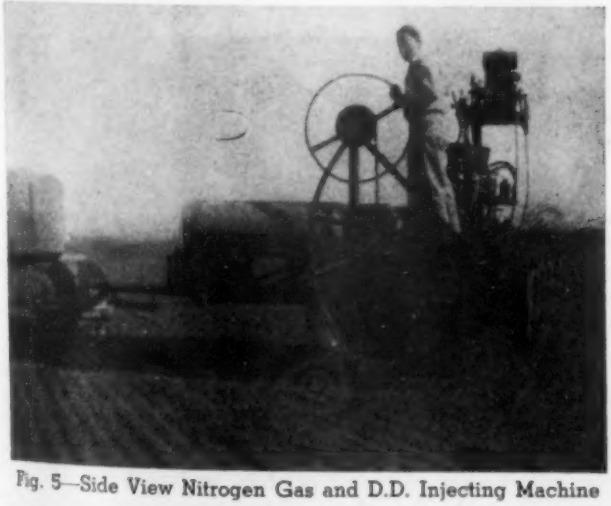


Fig. 5—Side View Nitrogen Gas and D.D. Injecting Machine

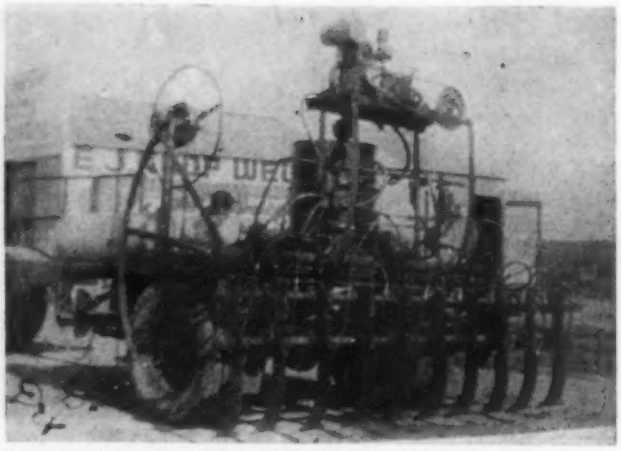


Fig. 6—Rear View Showing Chemical Delivery Pipes and Injecting Shanks

The potato digger is shown in Fig. 2. Pipe has proved good material for its construction, for its ability to withstand vibration, twist and strain of the digger in motion.

Figure 3 illustrates the slow turning back and forth joints or dry bearings make pipe a natural for its construction. One pipe slipped over another pipe such as the turntable assembly (see arrows) gives the front wheels free action to encounter a rise or side fall of uneven land; without diverting the digger too much from its intended course. The lift pipes are supported by $^{1}/_{2}$-in. flat plates which have a hole cut in them for the outside diameter of the pipe allowing the pipe to turn freely in its bearing. This will give sufficient wear for many years.

In Fig. 4 we see that again the salvaged car is put to work as the draper chain drive of the potato digger. The power take-off of the tractor drives the draper chain sprockets through a transmission and rear end of a Ford car.

The mechanical trailer shown in Fig. 5 is an interesting specimen and a comparative newcomer built by this shop. It was developed by Shell Chemical Co. for injecting liquid fertilizer N.H. 3 and a soil fumigant chemical known as D.D. into the ground for land fertilization, and control of Nematodes, a soil parasite.

Figure 6 illustrates how the liquids are fed into the ground under pressure by delivery pipes welded in back of $^{5}/_{8}$ x 3 in. plow steel injecting shanks which protect the pipes from wear and stoppage. The injecting shanks also serve as a shallow subsoiler. The trailer is designed for road travel as well as the field, which makes it readily portable from farm to farm.

Figure 7 shows the fifth wheel or turntable on this farm trailer was so designed to eliminate the cutting of a gusset plate to stiffen the channel iron bolster upright to

Fig. 7—Farm Trailer Turn Table Design. Eliminated Cutting of Gusset Plate from Bolster Upright to Turntable Upper Plate

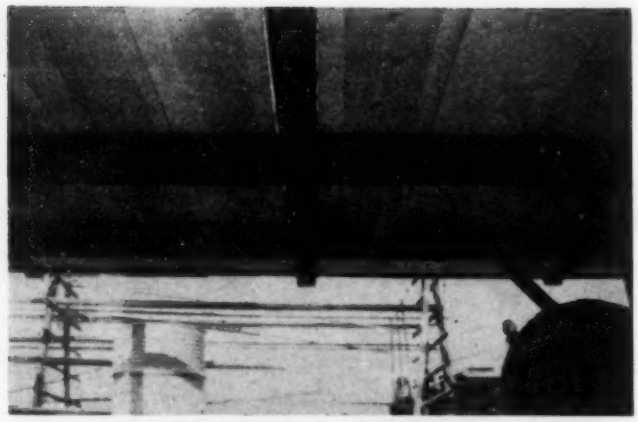


Fig. 8—Bottom View Farm Trailer Bed Showing Channel Iron Cross Arm on Top of Channel Iron Frame

the turntable plate. Heating the end of the angle iron and flattening it out filled the purpose of a brace and gusset, and provided one continuous member.

The bed frame of this farm trailer, Fig. 8, is angle iron and channel iron cross arms. By welding the channel iron cross arms on top of the main channel iron frame, they serve the purpose of a floor board and a cross arm. The floor boards are laid into the bed frame, then a $^1/_8$ x 1 in. iron strip is clamped down on top of the boards and tack welded every 3 in. to the angle iron bed frame. Two hundred and twenty-four bolts, 130 lb. of steel, and eight manhours were eliminated from each trailer. The trailer has greater rigidity than former design as shown in Fig. 9.

Figure 10 shows the completed 6 bale cotton trailer, light, durable, built from standard steel shapes.

Repair

Good repair of farm equipment parts compels the shop to be supplied with a wide variety of welding rods and fluxes. A scavenger cast-iron brazing flux has the ability to go down into the minute pores and crevices to gather up fine particles of foreign matter and floating them out ahead of the braze, for it is into these small crevices that your brazing metal flows and makes a good bond between the parent metal and weld metal.

Broken-out and worn-down teeth on cast gears and sprockets have been a major repair item for several years due to the scarcity of replacement parts. Building up these worn and broken out teeth is done with the arc welder, using a nickel cast-iron rod, which makes an excellent bond between the parent metal and the weld metal. Several layers are built up then changing to a mild steel rod for several layers then finishing off with a layer of hard-facing rod that has good abrasion and impact qualities. The gear or sprocket is then ground with a thin cutting wheel to fit the mesh of its partner gear or chain. This procedure makes a good bond between all metals. The gears and sprockets are able to stand just as much impact as a new part with longer wear.

Hard facing of earth-working tools such as plowshares, subsoiler teeth, chisel teeth, potato digger blades, is best accomplished by following the manufacturer's instructions, and improving upon them, by experiments of your own. The soil in your locality may require the use of one, two or three different hard-facing rods and procedures to obtain the most wear from the hard-faced part.

The plowshare in Fig. 11 is a good example of hard-facing procedure. Striping the plowshare on top every inch with an abrasion-resistant rod gives as good results from the earth's gouging action as a solid deposit would. Borium 30–40 mesh is applied by gas application to the underside of cutting edge, $^3/_4$ of an inch wide. The top edge is left exposed to receive the abrasive action of the earth and wears down to a thin edge. The borium on the back edge holds on until its binding agency is gone, then breaks off in small particles leaving a minute ragged sawtooth edge. This repetition of the earth's action on a plowshare goes on until all the hard-face is worn away. Then the share goes back again to the shop for repair and hard facing.

Only in extreme sandy soil should borium be applied on the upper side of the cutting edge. Experiments have shown a good hard-face job spoiled after several hours of service by applying on the top edge of plowshare. The full face impact of small pebbles and rocks in the soil caused the borium to flake off leaving the exposed metal which soon cut through the hard face line and on into the plowshare.

Had the borium deposit been applied on the underside, the plowshare metal is soft enough to absorb the impact of small rocks and pebbles, making the hard-face job serve its full duty.

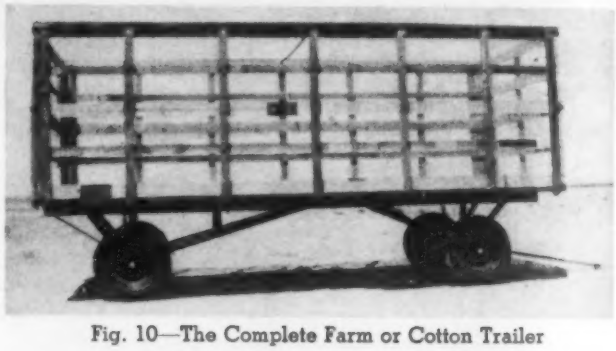


Fig. 10—The Complete Farm or Cotton Trailer

Fig. 11—Top View of Plowshare Showing Stripe Method of Hard Facing

Fig. 9—Former Design of a Farm Trailer Showing Bolted Construction

D. L. & W. 50-Ton Hopper Cars

By W. C. Osha*

THE construction of 500 50-ton steel hopper cars for the D. L. & W. has been completed at the American Car and Foundry Co., Berwick, Pa., plant.

These cars are of welded construction except for the attachment of safety appliances, draft gear carriers, side construction to body bolster web, diagonal braces with gussets and hopper door frames which is by rivets.

Open-hearth steel has been used for the general structural members and low-alloy high-tensile steel for parts in contact with the lading.

The principal dimensions of these cars are as follows:

Inside length	34 ft. 4 in.
Length over strikers	35 ft. 3 3/4 in.
Truck centers	25 ft. 4 in.
Inside width	9 ft. 8 5/8 in.
Width over top side bulb angles	10 ft. 5 in.
Height from rail to top of side top bulb angle	11 ft. 0 in.
Capacity level full	2221 cu. ft.
Capacity with 6-in. heap	2388 cu. ft.
Light weight	39800 lb.
Ratio of pay load to gross load per cent	76.4

Car Structure

The car is provided with two hoppers, four three-piece hopper chutes 1/4 in. thick, four wine hopper frames, four 5/16-in. pressed steel doors secured by wine master locks.

The center sills are A. A. R. 36.21-lb. Z-26 sections joined by welding.

The body bolsters are 21-in. 62-lb. CB sections having the top flange tilted to the slope of the floor sheet. The top flange is supplemented by a cover plate formed with a slight depression; the purpose of this cover plate is to serve as a cushion for the floor sheet at this location. Two 7-in. 14.75 rolled channels placed back to back form the side bearing struts. These struts are welded to the underside of the bolster bottom flange and are braced by means of a 7/16-in. tie plate riveted to the center sill flange.

The upper floor sheet is 7/32 in. thick; the hopper floor sheet 1/4 in. thick. The upper floor sheet is butt welded to the hopper floor sheets.

The crossridge floor is 1/4 in. thick and extends in one piece from hopper door frame to hopper door frame. The cross-bearer web is 1/4 in. thick flanged at bottom and stitch welded to the underside of the crossridge floor sheet.

The side sheets are in four sections all 3/16 in. thick, butt welded together. The side post at bolster is formed by a 6-in. 12-lb. ship building channel applied with back of web in contact with the side sheet. The intermediate side posts are 1/4-in. pressed channels with flanges in contact with side sheet. The top member of the side structure is a 4- x 3 1/2- x 3/8-in. bulb angle. The side sill is a 5- x 1/2-in. plate extending from bolster to bolster supplemented by a 5- x 3 1/2- x 3/8-in. rolled angle extending from bolster to end sill.

* General Supervisor, Welding, American Car and Foundry Co., Berwick, Pa.

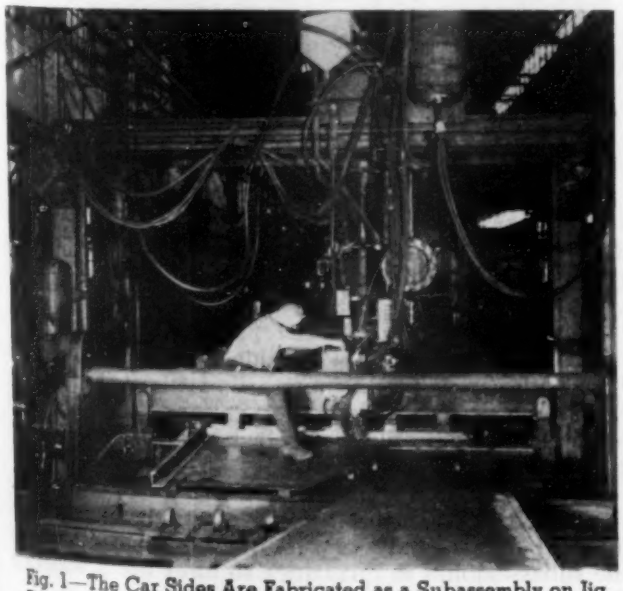


Fig. 1—The Car Sides Are Fabricated as a Subassembly on Jig Positioners. Here the Side Posts Are Being Fastened to the Sides Sheets by Machine Welding

Fig. 2—The Car Ends Are Brought to the Assembly Line by an Overhead Traveling Crane, Swung Into Place by Hand-Controlled Electric Hoists and Then Tack Welded

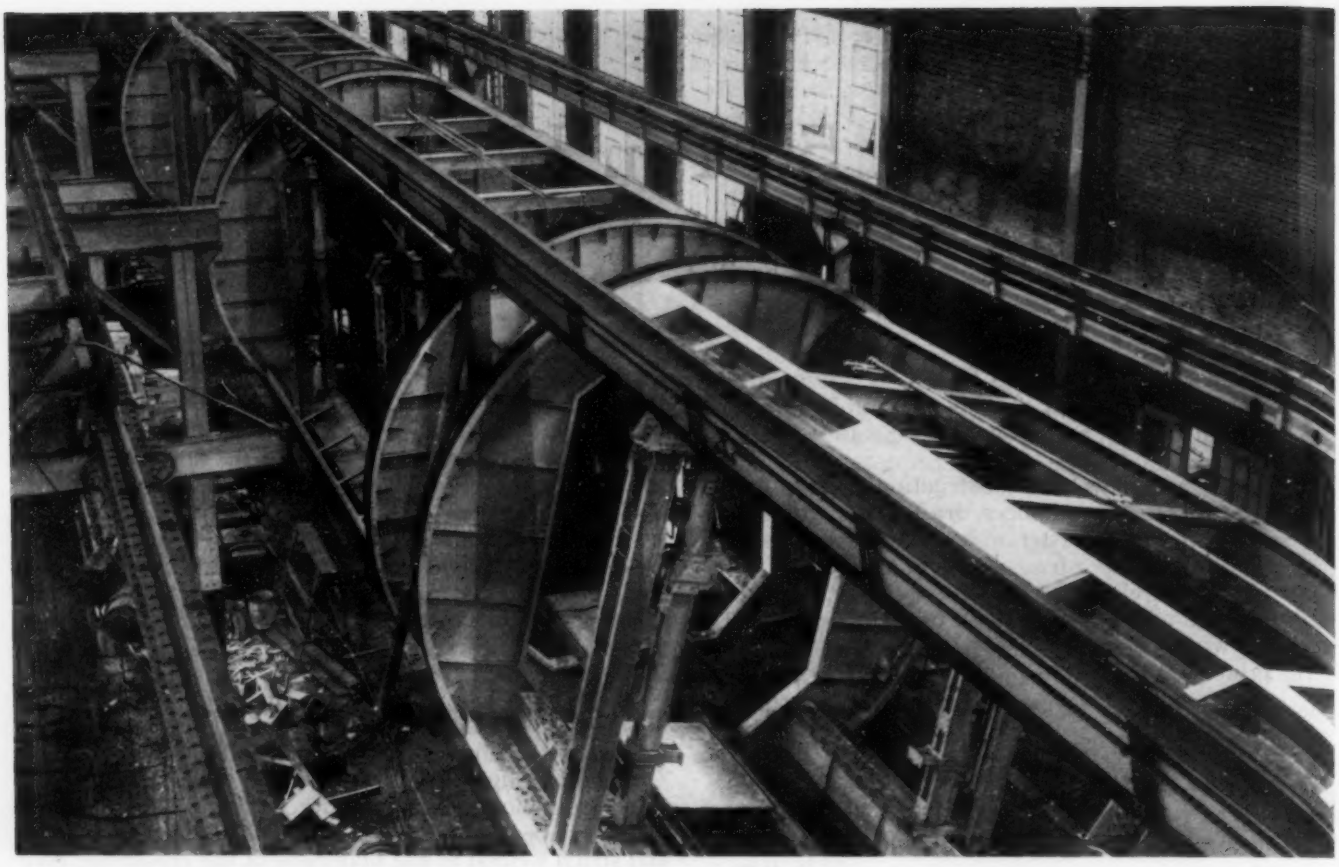


Fig. 3—The Rotating Positioners Are Shown in This View Looking Toward the Start of the Assembly Line. Before They Are Rotated the Cars Are Fitted with Temporary Inside Braces

The inside braces are of $^1/_4$-in. steel arranged with a tubular section at top portion. These braces extend diagonally from the top of the crossridge to a point below the top of the sides and stiffen the sides against transverse pressure.

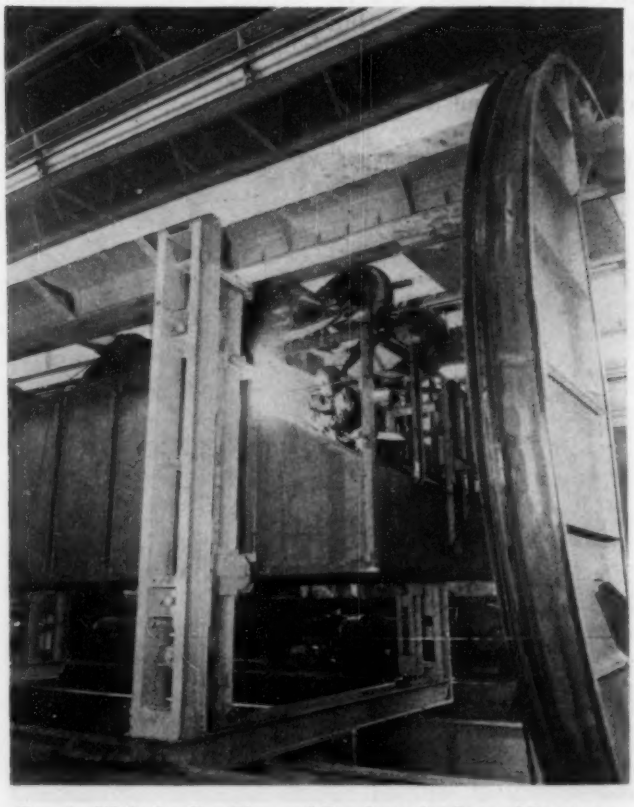


Fig. 4—With the Car Clamped Firmly in the Second Positioner it Is Rotated 180° to an Upside Down Position and All Welding on the Underside of the Car Is Completed

Fig. 5—After Leaving the Last Rotating Positioner the Car Is Equipped with Piping and Air Brakes and Then Is Rolled Off the Assembly Line Ready for the Last Job of Painting

The longitudinal hoods are $^1/_4$-in. pressed steel.

The end sheets are $^3/_{16}$ in. thick with a 4- x $3^1/_2$- x $^3/_8$-in. bulb angle top member. End sills are 6- x $3^1/_2$- x $^5/_{16}$-in. rolled steel angles. Corner posts, posts at hand brake and ladder stiles are rolled angles—intermediate end posts are rolled channels.

The preparation work for the construction of these cars required considerable study in the development of jigs and fixtures necessary for the machine welding of the subassemblies in quantities to meet the production line requirements.

The subassemblies are arranged as follows:

Center sills with draft attachments and ties.
Upper floor sheet, hopper chute floor sheet, and body bolster beam with angle connections.
Crossridge with crossbearer.
Side sheets with top bulb angle, side sill, bolster posts and intermediate posts.
End sheet with top bulb angle, posts, ladder stile with ladder rounds in place, end sill brake platform brackets and hand brake unit.

The above subassemblies including the trucks and smaller units such as hopper sheets frames and longitudinal hoods are assembled to form the car structure. Some of these members are tack welded and some held in place by fitting bolts and rivets—following which they are placed in three separate progressive positions in a rotating jig for the completion of the hand welding and final assembly of the car.

Pipe Columns for Crane Runway Support Increases Rigidity

By Charles G. Herbruck*

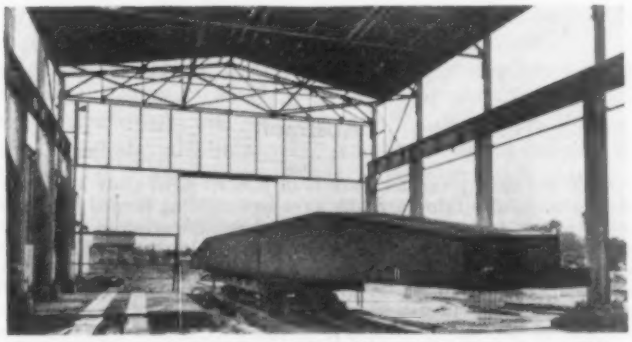


Fig. 2—View of a Fabricating Bay Using 18-In. Diameter Pipe as Column Support for 40-Ton Load on the Crane Runway

IN designing, welding and erecting their own plant additions, the Milwaukee Crane and Service Co. of Milwaukee, Wis., choose pipe for the columnar support of their crane runways (Figs. 1 and 2).

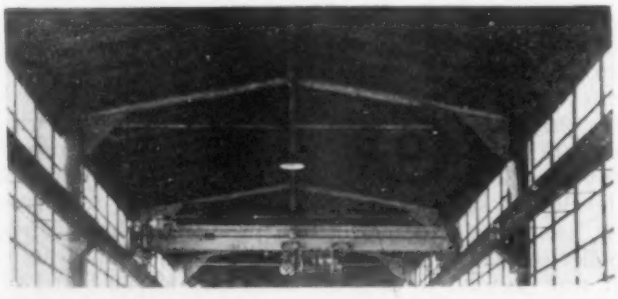


Fig. 1—Details of Columns and Trusses of Pipe Used in the Welded Erection of a Plant Addition

Increased production demanded added plant capacity for the fabrication of crane box sections. A large bay was designed with a crane across the span carrying a 40-ton load. For the crane runway, standard I-beams were used. To support these I-beams, columns were erected using 18-in. diameter pipe with a $^3/_8$-in. wall thickness (Fig. 2).

The pipe columns were continuously welded to an anchor plate which in turn was bolted to a concrete footing. The runway I-beams were welded to a square $^1/_2$-in. thick plate welded on top of the pipe columns.

To add further stiffness to the columns and obtain vertical supporting members for the roof, I-beams were welded to the column. These beams extended from the concrete footing to the roof. They were continuously welded to the anchor plate. Added strength and supporting area were gained by removing the flange of the I-beam for the length of the pipe, and joining it to the pipe by welding on both sides of the web (Fig. 3).

The use of pipe for the crane runway support achieved a combination of economy, strength and rigidity which could not have been accomplished using standard I-beams. By filling the pipe with concrete, it is expected to increase the load to seventy tons.

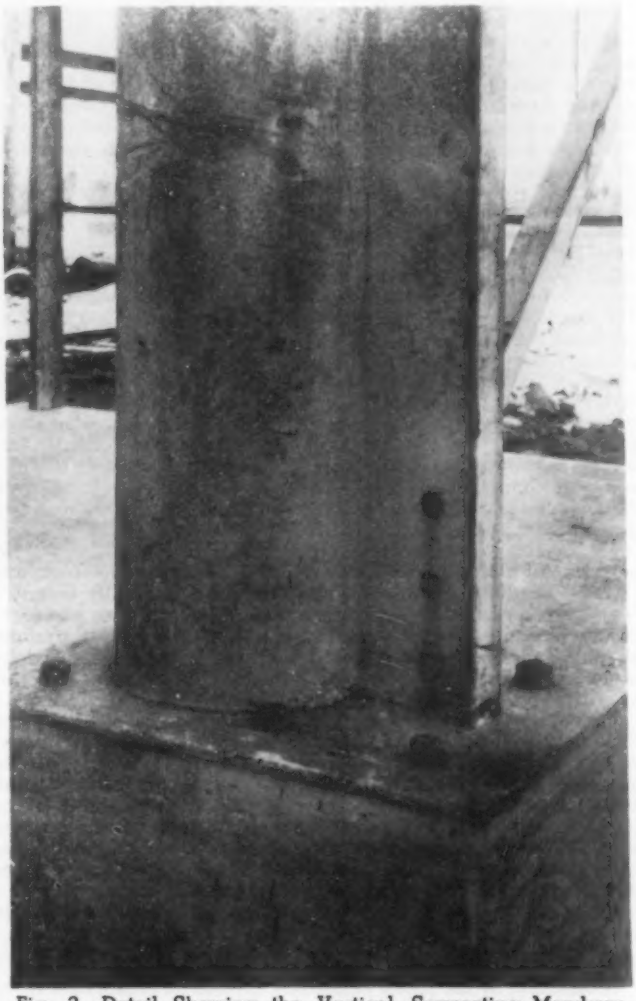


Fig. 3—Detail Showing the Vertical Supporting Members for the Roof As Welded to the 18-In. Pipe Columns, and the Welding of Columns to the Anchor Plate

* Assistant to the Secretary, The Lincoln Electric Co., Cleveland 1, Ohio.

Pressure Welding Propeller Barrels*

By G. W. Motherwell,† A. L. Rustay,† S. M. Jablonski† and C. J. Burch‡

Abstract

High strength propeller barrels of S.A.E. 4345 alloy steel have been successfully fabricated by pressure welding forged front and rear sections to form the assembly. A modification of the closed joint method employing the use of a multiple pressure cycle was used, and the welding technique developed to the point where welds satisfactory for these applications could be made and duplicated. The pressure welding process was chosen as it showed promise of producing adequate welds with a low initial investment.

The program for the development of the process was divided into three parts.

I. Experiments in pressure welding S.A.E. 4345 steel.
II. Experimental pressure welding of barrels.
III. Design of production equipment and the establishment of procedures and controls so that parts could be produced to quality and quantity requirements.

Tests were made in both straight $^3/_4$- x 5-in. sections, and 8-in. long, 4-in. inside and $5^1/_2$-in. outside diameter cylinders to simulate the arms of the barrels. From these it was learned that S.A..E 4345 steel could be readily welded, and that the mechanical properties of the best welds were equal to those of unwelded material. Difficulty was experienced in obtaining a proper bond to the ends of the cylinders as these ends had opened during the welding cycle due to thermal expansion. This condition was remedied by relieving the holding dies so that only the ends of the cylinders were supported, and so that the pressure was higher at the ends. Smooth, flat abutting surfaces required were readily prepared by surface grinding. Initial pressures of 6000 to 10,000 psi. were used to assure intimate contact during the first part of the heating cycle. During the second stage of the cycle, pressures were 1800 and 2000 psi., and the pressure for final upsetting was maintained at 4000 psi. until the desired shortening was obtained.

One of the most difficult problems encountered was that of uniformly and simultaneously heating either 3 or 4 kidney shaped sections to proper temperature. The original barrel design was altered so that the weld surface would be of a uniform $^{11}/_{16}$ in. thickness throughout, and sharp corners and angles were avoided as an aid to uniform heating. Special water-cooled heating heads were made for each barrel design. External heads were mounted directly to a carrier plate, and internal heads were set in a cam track to permit easy insertion and removal from the interior of the barrel. All internal heads were manifolded to one blowpipe, and external heads to another. This system automatically balanced heat input for each group of heads, and it was a simple matter to adjust internal and external heating rates to provide uniform heating. Flow of gases required for welding was controlled by attaching gages to the blowpipes and using the blowpipe injectors as critical orifice flowmeters.

Experience with the welding of experimental barrels indicated that weld technique and quality of welded assemblies were governed by the type of equipment used. A four-column hydraulic press was built to a design that would afford maximum rigidity and assure accuracy of dimensions on welded assemblies. Welding tools for each barrel design were mounted on separate interchangeable die holders and carrier plates. Copious water cooling was employed throughout to prevent binding and thermal expansion of the equipment in operation.

It was necessary to stress relieve the assemblies immediately after welding to eliminate the formation of cooling cracks, and to machine weld upsets prior to heat treatment to prevent quench crack propagation from the notches at these upsets.

A rigid system of quality control was instituted to insure soundness of the assemblies throughout all production stages. The welds were examined by magnaflux, and a percentage of assemblies welded were sectioned. Sections taken from these were deep acid etched, and tensiles were taken at various locations through the welds. Once a satisfactory weld cycle had been determined for a given job, instructions were issued to operators, and examination of the cycles used for each assembly welded afford a fair criteria as to the progress of the welding operation.

Introduction

PRIOR to the development discussed in this paper, propeller hubs for controllable pitch propellers in this country have been of two types; the split type hub consisting of two forged half barrels bolted together, and the solid or one-piece hub. Desiring to retain certain features of both of the types, the Hamilton Standard Propeller Division, United Aircraft Corp., became interested in a welded type of propeller hub consisting of two forged half barrels, which after preliminary machining are welded together to form a one-piece structure. Wyman-Gordon was asked to take on this project of developing satisfactory forging and welding techniques. At least one British firm had produced fabricated propeller barrels by flash welding two steel components.[1, 2] It was decided to pressure weld two forged barrel sections together to form the assembly. The pressure welding process was chosen because, for this application, it showed promise of producing adequate welds, with a considerably lower initial investment than would be needed for flash welding. It was planned to keep total production costs of these new propeller barrels to a minimum by eliminating as much machining as possible. Therefore, both the forgings and the welded assemblies were made to closer than usual tolerances for this kind of work.

The steel, S.A.E. 4345, was chosen so that the assemblies could be air quenched to the specified mechanical properties without the necessity of using a fixture to insure dimensional stability during heat treatment.

The development program was divided into three sections as follows:

I. Experiments in pressure welding S.A.E. 4345 steel to produce satisfactory welds. This data would serve as a guide for the subsequent work in Section II.

II. Experimental pressure welding of barrels. This included the development of oxyacetylene heating equipment, dies and pressure fixtures and heating cycles to consistently produce assemblies with the required strength.

III. Design of production equipment and the establishment of procedures and controls so that the parts could be produced to quantity and quality requirements.

* Contributed by the Metals Engineering Division for presentation at the Semi-Annual Meeting of The American Society of Mechanical Engineers, Chicago, Ill., June 16–19, 1947.
† Wyman Gordon Co., Worcester, Mass.
‡ The Linde Air Products, Pittsburgh, Pa.

Fig. 1—The Two Forged Barrel Halves, Machined and Ready for Welding, Are Shown at the Left. The Assembly Immediately After Welding Is Shown at Center. The Heat-Treated Assembly with Weld Upset Removed, Ready for Shipment, Is Shown at the Right

The sequence of operations finally arrived at to produce these assemblies is illustrated in Fig. 1. The two forged barrel halves, machined and ready for welding, are shown at the left. The assembly immediately after welding is shown at center. The heat-treated assembly with weld upset removed, ready for shipment, is shown at the right.

I. Experimental Welds

Essentially, the pressure-welding process consists of heating two clean abutting surfaces to a high but subfusion temperature, then upsetting at this temperature to produce a weld. Several methods of accomplishing this have been reported in detail.[5–8] A modification of the closed joint method involving the use of a multiple pressure cycle was used for the present work. High initial pressure was applied for the first stage of welding, with a low intermediate pressure until the desired temperature was attained. The pressure was then raised to produce the desired upset.

The first test welds were made with 6 in. lengths of $^1/_2$- x $5^1/_2$-in. flats of S.A.E. 4340 steel, and $^3/_4$- x $5^1/_2$-in. flats of S.A.E. 4345 steel. After a number of sound welds were made and the proper temperature at the interface had been established, additional test pieces, designed to simulate the arm sections of the barrels, were joined by two diametrically opposite pressure welds to form cylinders 8 in. long, 4-in. I.D. and $5^1/_2$-in. O.D. After a full heat treatment consisting of a normalize, harden and draw to 286–321 Brinell hardness, weld quality was determined by Magnaflux, hot acid etch and micro examination. Tensile test specimens were cut from the cylinders and the properties through the best welds, after the beads had been removed, were the equivalent of those for the base material. Whereas all welds possessed satisfactory yield and ultimate strengths, the elongation and reduction of area values of a number of welds were lower than those of unwelded base material, and examination of these tensile pieces disclosed that they had parted exactly at the weld with a flat fracture, with little or no "necking down." Tensile properties through a number of test welds are listed in Table 1. Difficulty was experienced in obtaining a proper bond at the ends of the cylinders, as the ends had opened during the weld cycle due to thermal expansion. Satisfactory results were obtained by relieving the holding dies so that only the ends of the cylinders were supported.

Experience gained from these test cylinders indicated that S.A.E. 4345 alloy steel could be satisfactorily pressure welded rather easily, provided that the heat input could be adjusted so that all sections would reach the welding temperature simultaneously, and provided that the pressure could be applied and maintained essentially normal to the mating surfaces. Flat smooth abutting surfaces were prepared by surface grinding. Initial pressure of from 6000 to 10,000 psi. were used to assure intimate contact during the first part of the heating cycle. During the second stage of the cycle, pressures were 1800 and 2000 psi. and the pressure for final upsetting was maintained at 4000 psi. until the desired shortening of $^1/_4$ to $^1/_2$ in. was obtained.

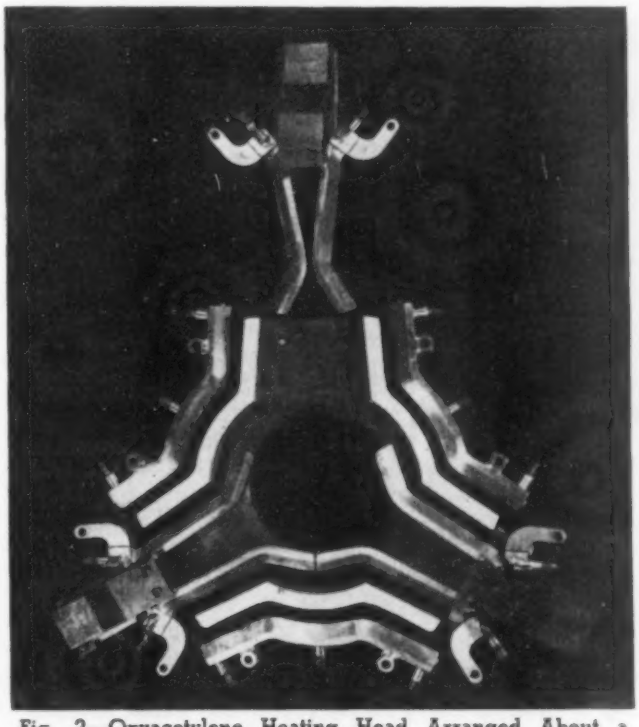


Fig. 2—Oxyacetylene Heating Head Arranged About a Three-Armed Propeller Barrel. One Set of Internal Heads Is Shown in the Retracted Position

Table 1—Tensile Properties of Test Welds

Test	Yield Strength 0.2% Set, Psi.	Ultimate Strength, Psi.	Elongation % in 2 In.	Reduction of Area, %	Brinell
Best welds	126,750	142,500	19.0	49.1	293
	127,500	142,000	19.5	51.0	293
	131,000	143,000	19.0	50.2	302
Unwelded control samples	125,500	140,000	17.5	40.0	293
	133,500	141,500	18.0	43.3	302
Tests that parted exactly at the weld with a flat fracture	123,800	141,000	15.0	26.6	302
	137,000	144,000	10.0	18.0	321
	132,000	144,500	9.5	10.6	302

NOTE: Best welds obtained have properties slightly better than unwelded control samples heat treated to the same Brinell hardness range.

II. Experimental Pressure Welding of Barrels

One of the most difficult problems involved was that of uniformly and simultaneously heating either 3 or 4 kidney shaped sections to the proper temperature. The original barrel design was altered so that the weld surface would be of a uniform $^{11}/_{16}$ in. thickness throughout, and sharp corners and angles were avoided as an aid to uniform heating. Special water cooling heads were made for each of the barrel designs. The external heads were mounted directly to a carrier plate, and the internal heads were set in a cam track mounted on the carrier plate to permit easy insertion and removal of heads from the interior. The heating heads for the three-armed barrel are shown arranged about a half section in Fig. 2 with one set of internal heads retracted. Those for the four-armed barrel are shown attached to the carrier plate in Fig. 3 with a barrel section in position. As can be seen from these photographs, the internal head design was governed by the small clearance at the inner cone of the rear half forging. The size of the flame ports on these heating heads was adjusted by trial and error methods until a uniform heat distribution was attained throughout the weld section, and the heating heads balanced so that all sections were heated at the same rate.

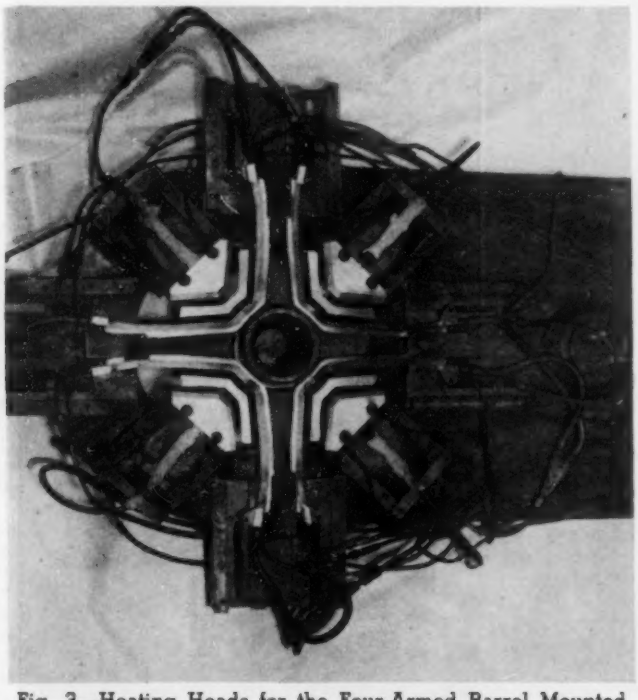


Fig. 3—Heating Heads for the Four-Armed Barrel Mounted on the Carrier Plate with a Rear Half Section Set in Position. Note the Small Clearance Between Internal Head and the Inner Cone

The equipment used for this experimental development work is shown in Fig. 4 with a barrel in welding position. Pressure was built up by means of a motor-driven hydraulic pump which operated a piston in the oil cylinder at the top of the press. Oscillation of the heating heads across the weld was provided by motor driven vertical movement of the carrier plate. Secondary air required to burn off excess gases from the interior of the barrel was supplied by means of a line running up through the center of the bottom die.

The ends of the arms failed to weld on the first barrels because they opened during the early heating stages just as the test cylinders had. The holding dies were relieved in order to support the ends only, and the fit between the forgings and holding dies was improved by coining the

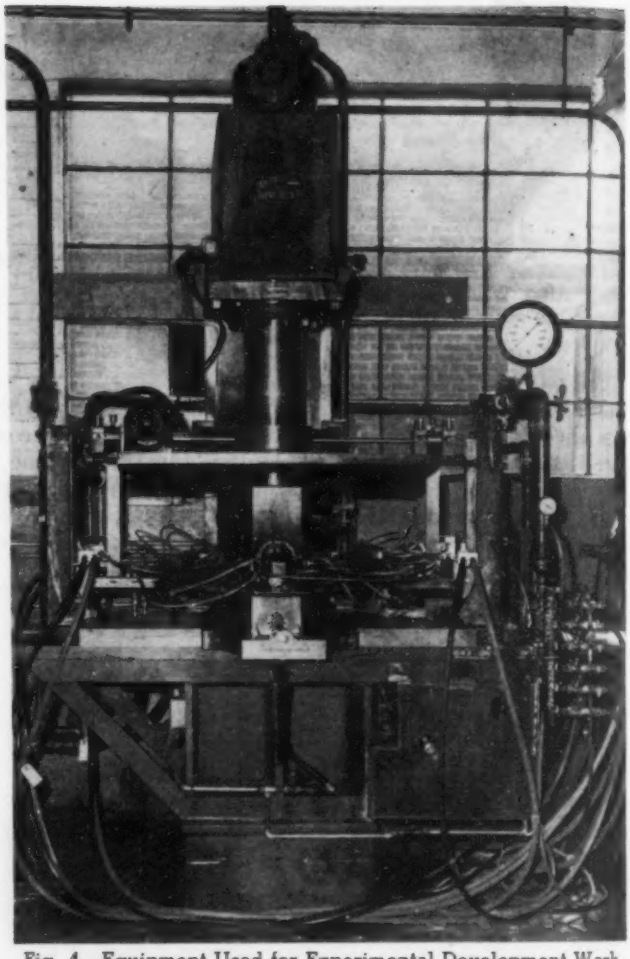


Fig. 4—Equipment Used for Experimental Development Work in the Pressure Welding of Propeller Barrels

arms as a final operation. Subsequent barrels were welded with a starting pressure of 10,000 psi. across the weld. The faces remained closed during the entire welding operation, resulting in good welds throughout the section. This equipment had been made only for the required development work, but proved satisfactory for limited production until semiautomatic, more rigid, equipment was constructed for production requirements.

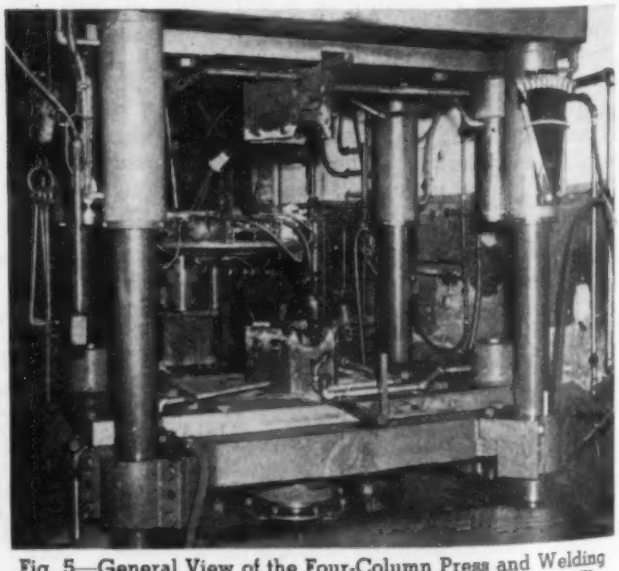


Fig. 5—General View of the Four-Column Press and Welding Equipment Used for Pressure Welding Propeller Barrels. The Carrier Plate Has Been Withdrawn to Facilitate Loading

III. Design of Equipment and Welding of Barrels for Production

The development work had indicated the importance of properly designed equipment. A four-column press was built because the rigidity of this design would assure dimensional stability of the weldments by preventing die shift that would result in mismatched assemblies. A rising platen was used so that the oil cylinder could be placed in the bed to prevent heating of the hydraulic system. The welding equipment for each barrel design was arranged as an integral unit mounted on a separate interchangeable carrier plate. Large diameter guide pins fitted into bushings to insure accurate alignment of the dies. A rectangular guide pin was placed between the die holders and carrier plates to maintain exact spacing of heating heads about the barrel. To prevent thermal expansion and binding of the equipment in operation, water cooling was employed for the columns, guide pins, head, die holders, dies and carrier plate. The carrier plate, holding the heating heads and oscillation mechanisms, was mounted on a conveyor so that it could be moved forward and then raised into welding position after the barrel halves had been positioned, and withdrawn after welding to facilitate removal of work. A general view of the welding press is shown in Fig. 5. Here the carrier plate has been withdrawn and the press is ready for loading. Figure 6 shows the press loaded, with the carrier plate brought into position and the internal heating heads in welding position. A barrel immediately after welding is shown in Fig. 7. Here the platen has been lowered and the carrier plate retracted.

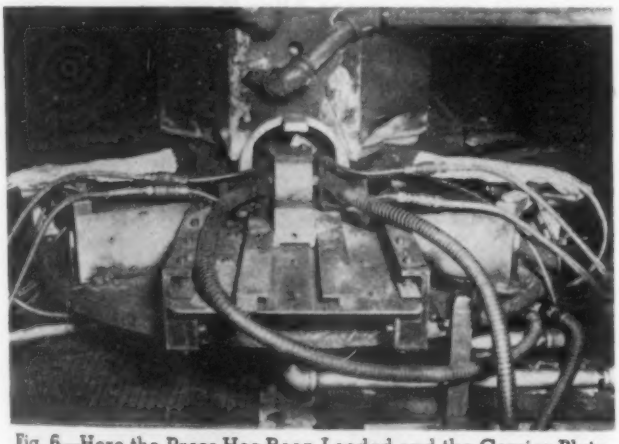


Fig. 6—Here the Press Has Been Loaded and the Carrier Plate Has Been Swung into Position and Made Ready for the Welding Operation

The heating heads used for the experimental work were supplied with gases by means of six blowpipes, and required the adjustment of twelve individual valves to provide a balanced heat input. As this system proved cumbersome and difficult to operate properly, it was simplified by manifolding all internal heads to one blowpipe and all external heads to another blowpipe. A diagrammatic sketch of this arrangement is shown in Fig. 8. This method proved highly successful as it automatically balanced the heat input from section to section, and it was a simple matter to equalize internal and external heating rates. Flow of gases was adjusted by means of one oxygen and one acetylene valve in the lines supplying each blowpipe. Volumes of gases used were set by means of pressure gages placed directly after the needle valves. A flow chart calibrated for the blowpipes used is shown in Fig. 9, and the gas pressures required for neutral flames and a balanced heating rate are plotted.

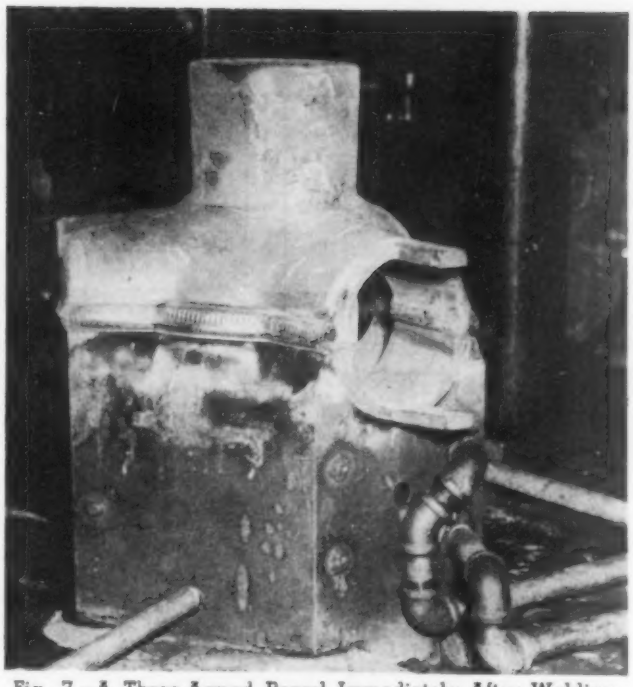


Fig. 7—A Three-Armed Barrel Immediately After Welding. The Platen Has Been Lowered and the Carrier Plate Retracted to Facilitate Loading

The operator was able to maintain proper gas flow by very slight adjustments of four needle valves, and was able to reproduce the cycle on successive welds.

The gases used were taken from shop pipe lines. Oxygen was supplied from a large storage unit, and generators supplied the acetylene. The effects of fluctuations and drops in line pressure on welding were eliminated by a system of regulation. Delivery pressure regulators

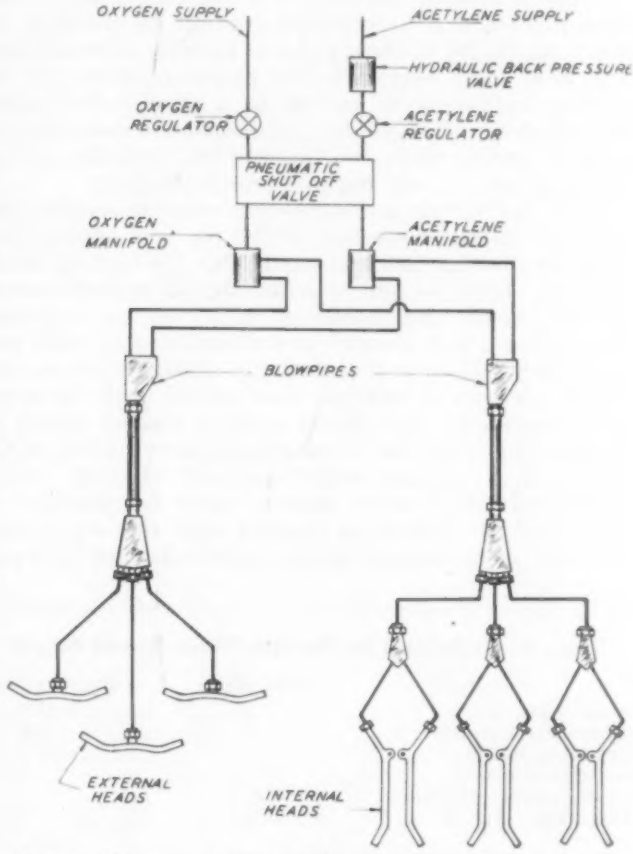


Fig. 8—Diagram of Oxyacetylene Equipment for a Three-Armed Barrel

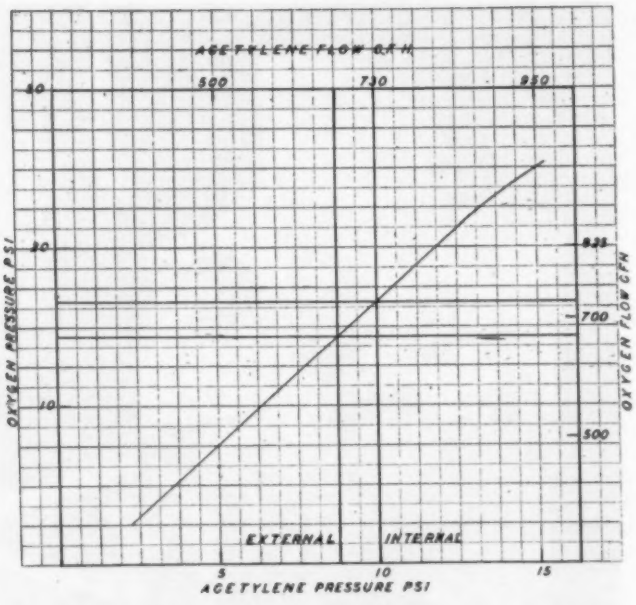


Fig. 9—Gas Flow Chart for Controlling the Flow of Gases to the Heating Heads for the Three-Armed Propeller Barrel

were used to reduce the pressure in the supply lines to slightly above working pressures, and in the case of oxygen this was accomplished in two stages by the use of two regulators. Needle valve adjustment was then used to maintain proper pressures at the blowpipes. This method minimized the effect of small fluctuations in gas pressure, and drops in line pressure did not alter the flow of gases as line pressure was always well above working pressure. A pneumatically operated shut-off valve was used to start and stop the flow of gases at the start and completion of welding.

Prior to welding, the interior of the barrel half bodies were machined to a spherical contour to eliminate as much machining of these areas as possible after welding. The weld areas were milled to proper contour and the mating surfaces were ground to a smooth flat finish. Immediately after grinding, the surfaces were oiled to prevent rusting while awaiting welding, and this oil film was removed by a solvent just prior to welding.

After the barrels and equipment were in welding position an initial pressure of 10,000 psi. was applied, the oscillating mechanism was started and the heating heads were lit. High pressure was maintained until the metal became plastic, and shortening of $^1/_{16}$ in. had occurred. The pressure was lowered and maintained at 1800 psi. until the metal became sufficiently plastic, when an upsetting pressure of 4000 psi. was applied until the upset was completed. The platen came to rest by means of positive stops, and the heating heads were turned off by means of a pneumatically operated shut-off valve. Experiments had shown that a center temperature of 2200–2250° F. had been reached with this equipment when the metal became plastic under a load of 1800 psi.

Table 2—Cycle Used for Welding Three-Armed Barrel

	Time, Min.	Pressure, Psi.
Starting pressure	...	10,000
Intermediate pressure	...	1,800
Upsetting pressure	...	4,000
Initial plastic state	2.4	...
Upset pressure applied	4.8	...
Total time	6.75	...

Total shortening used: $^1/_2$ in.

Table 3—Time Cycles in Minutes for Various Amounts of Total Shortening

Shortening	$^1/_4$ In.	$^5/_{16}$ In.	$^3/_8$ In.	$^7/_{16}$ In.	$^1/_2$ In.
Initial plastic state	2.37	2.36	2.4	3.39	2.4
Upset pressure applied	4.41	4.35	4.44	4.61	4.81
Total time	5.04	5.44	5.99	6.33	6.73

The amount of upset used was that which resulted from a total shortening of $^1/_2$ in. The total time required for welding a three-armed barrel was 6.75 min., and the welding cycle employed is listed in Table 2.

Although a total shortening of $^1/_2$ in. was used, satisfactory welds were obtained when this was as little as $^1/_4$ in. However, since the carrier plate was set to provide a proper heat zone with a $^1/_2$ in. total shortening, lesser amounts raised the main heat zone above the weld by the difference between $^1/_2$ in. and the actual amount of total shortening. The result of this was to decrease the amount of effective upset at the weld, and caused the arms of the rear half barrel to be out of round. The effect of amount of total shortening on the welding cycle was studied, and the results are listed in Table 3. Although the times to attain the initial plastic state and times to apply upsetting pressure were unaffected, the total time for welding was indirectly proportional to the amount of total shortening. This relationship proved useful in predicting weld quality when comparisons were made with assemblies that previously had been successfully welded.

Treatment After Welding

Stress or cooling cracks were found in the weld zone of a number of assemblies that had been allowed to air cool to room temperature after welding. These cracks were eliminated by use of a stress relief heat treatment. Immediately after welding and before the weld zone had cooled to below 600° F., the assemblies were placed in a furnace operating at 1200° F. and held at this temperature for two hours when they were air cooled. This time and temperature was used because, in addition to affording a protection against stress cracking, it resulted in good machinability for this steel. It was found neces-

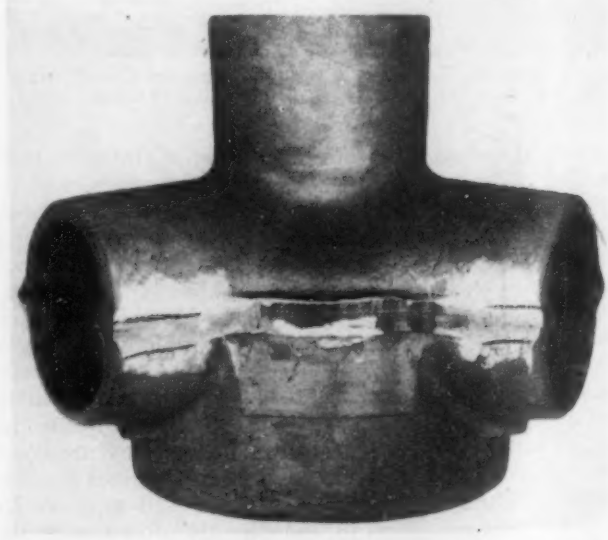


Fig. 10—Magnaflux Indications Due to Quench Cracks Resulting When Weld Upset Had Not Been Machined Prior to Heat Treatment Are Shown at the Arms of a Three-Armed Barrel

sary to machine off the weld upsets before heat treatment because the notch effect of the outer edges of these upsets was sufficient to cause quench cracks. An example of this is shown in Fig. 10 where the quench crack had been brought out by magnaflux. This trouble was entirely eliminated after the weld upset had been removed prior to heat treatment.

The welded assemblies were heat treated to a Brinell hardness of 286 to 321 with a normalize, harden and draw. The normalizing treatment was used to refine the grain of the heat-affected zone at the weld. Since it was planned to use these parts with some of the original forged surface present, the welded assemblies were given a carbon restoration treatment during the hardening operation to recarburize the normal decarburized surfaces of the forging. For this purpose a sealed muffle furnace was used, and an artificially generated atmosphere was employed. The barrels were quenched from this furnace by means of an air blast to minimize distortion. The prime reason for choosing S.A.E. 4345 steel for these barrels was that it could be air hardened with very little distortion, and dimensions therefore could be maintained.

Tests to Determine Weld Quality

All assemblies were magnafluxed after the weld upsets had been removed. A number of barrels were sectioned and the welds were examined visually and after a deep acid etch in hot 50% hydrochloric acid. Typical etched sections taken from the arms and body are shown in Fig. 11. Tensile tests through the welds were taken at various locations as shown by the diagram of Fig. 12. The circles represent tensile test locations, and the dotted lines represent the location of slices to be given a deep acid etch. Tensile properties are listed in Table 4. Although all yield and ultimate strengths were satisfactory,

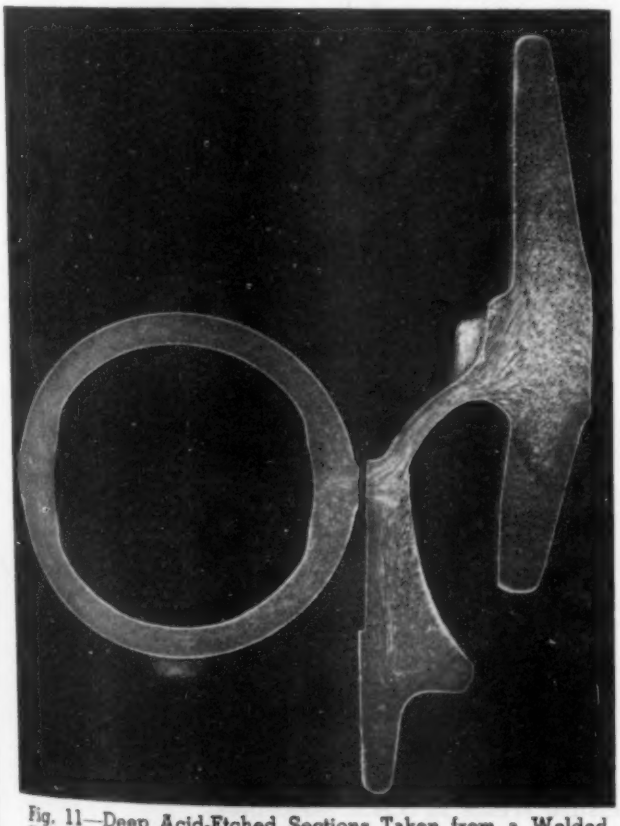


Fig. 11—Deep Acid-Etched Sections Taken from a Welded Barrel Assembly. Left, Section Through One of the Arms. Right, Section Through the Body Midway Between the Arms

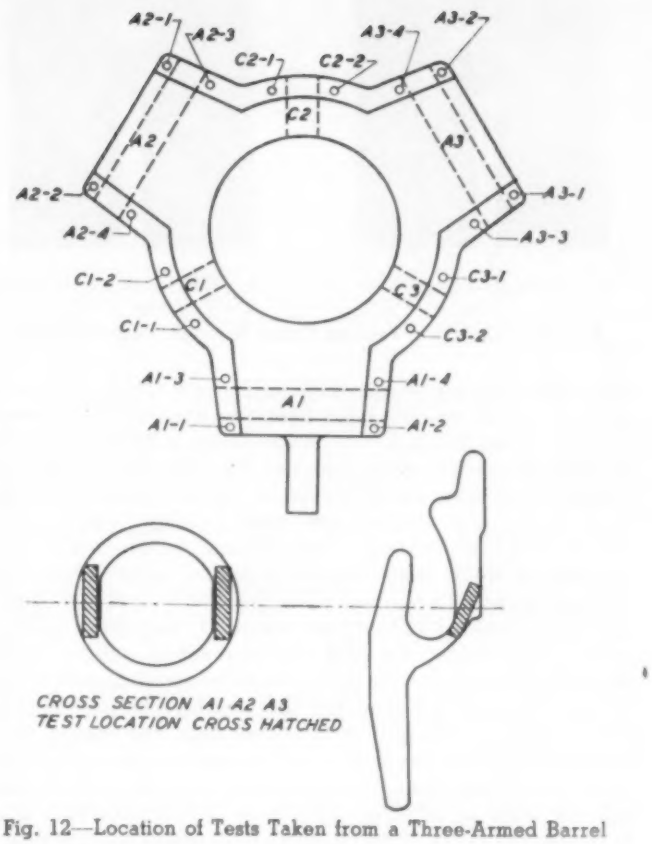


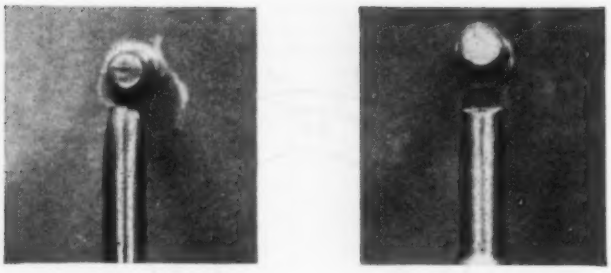
Fig. 12—Location of Tests Taken from a Three-Armed Barrel

the elongation and reduction of area values of some of the tests, illustrated by specimens A1-1, C1-1, A3-1 and C3-2 for this particular barrel, were lower than had been expected. Examination of the broken tensile pieces indicated that they had parted exactly at the weld with a flat type of fracture showing little ductility. Normal fracture was of the cup-cone type, influenced to some extent by the grain flow, and tensiles with this type of fracture always possessed good ductility with satisfactory strength. The two types of tensile fractures are compared in Fig. 13. Whenever tensiles through welds failed with this flat type of fracture, the reduction of area values were low. The appearance of the weld inter-

Table 4—Tensile Properties Through a Three-Armed Barrel Welded in Production

Test No.	Yield Strength 0.2% Set, Psi.	Ultimate Strength, Psi.	Elongation % in 1 In.	Reduction of Area, %	Fracture
A1-1	124,400	144,800	10.0	15.8	Flat
A1-2	122,000	142,900	17.0	47.5	Cup-Cone
A1-3	124,600	145,200	16.0	30.1	Cup-Cone
A1-4	120,250	141,100	18.0	50.5	Cup-Cone
C1-1	126,400	145,200	14.0	29.6	Flat
C1-2	124,400	144,800	15.0	36.8	Cup-Cone
A2-1	117,700	140,300	14.0	33.7	Cup-Cone
A2-2	124,600	144,800	19.0	52.6	Cup-Cone
A2-3	123,800	144,000	16.0	35.7	Cup-Cone
A2-4	115,600	138,300	14.0	35.7	Cup-Cone
C2-1	112,400	137,500	17.0	42.3	Cup-Cone
C2-2	117,300	140,750	17.0	49.0	Cup-Cone
A3-1	123,600	143,800	11.0	20.4	Flat
A3-2	124,600	145,200	18.0	46.9	Cup-Cone
A3-3	124,600	145,900	13.0	18.9	Cup-Cone
A3-4	124,000	144,800	16.0	35.7	Cup-Cone
C3-1	124,400	145,200	17.0	46.5	Cup-Cone
C3-2	124,200	144,000	8.0	14.3	Flat

NOTE: These results are typical of 20 barrels sectioned for tests.



A. Normal Cup-Cone Type

B. Flat, Parting Exactly at the Weld

Fig. 13—Fracture of Tensiles Taken Through Pressure Welds

face when examined microscopically and the reduction of area on tensile testing have been reported as the severest criteria of weld quality.[5] Experience with the welding of these barrels lends support to the contention that the reduction of area and the type of tensile fracture are the best indication of pressure weld quality when using S.A.E. 4345 alloy steel. Microscopic examination of a number of welds with low reduction of area values and flat tensile breaks showed complete coalescence of grains across the weld. It had been thought that these inferior welds were caused by dirt or a deposit of oxides at the abutting surfaces to be welded, or by areas that had not attained proper temperature during the welding process. Microscopic examination revealed that the welds were remarkably clean, and that oxides were absent. These areas may have been slightly below proper temperature but the weld at adjacent locations was satisfactory and examination of the data in Table 4 showed that these less ductile locations were widely separated. On other assemblies tested, flat tensiles with low values of reduction of area occurred at entirely different locations. The exact cause of these poorer welds is not known.

The use of an etchant for the detection of oxygen in steel, and its application in evaluating weld quality has been described in recent literature.[7, 8] Specimens taken through a large number of welds from barrel assemblies were etched with this reagent. There seemed to be no correlation between the results obtained with this etchant and low elongation, reduction of area or a flat type of failure on tensile testing. A fine white band of oxidized metal was present on specimens taken through welds with both high and low ductility and both types of welds sometimes showed complete absence of this oxidized metal. Typical structures of welds, both with a picral etch and the oxygen-detecting etch, are shown in the photomicrographs of Fig. 14. The conclusions drawn from this work were that:

1. The band of light etching metal present in these specimens had no effect on the tensile properties.
2. Fracture, elongation and reduction of area values obtained on tensile test offered a more sensitive means of evaluating weld quality than the oxygen-detecting etch.

Quality Control

Since these pressure-welded barrels encounter high operating stresses in service, they are produced under a rigid system of quality control. This system begins with the steel, of electric furnace aircraft quality, used for making the forged halves.

The dimensions of the two half forgings used to make the welded components must run true as the tolerances are relatively close. They must fit the welding dies exactly for proper bearing, particularly at the ends of the arms to insure soundness throughout the weld.

The welded assemblies are magnafluxed after the weld upsets have been removed, prior to heat treatment, and are again magnafluxed after heat treatment to insure soundness of the assemblies before shipment.

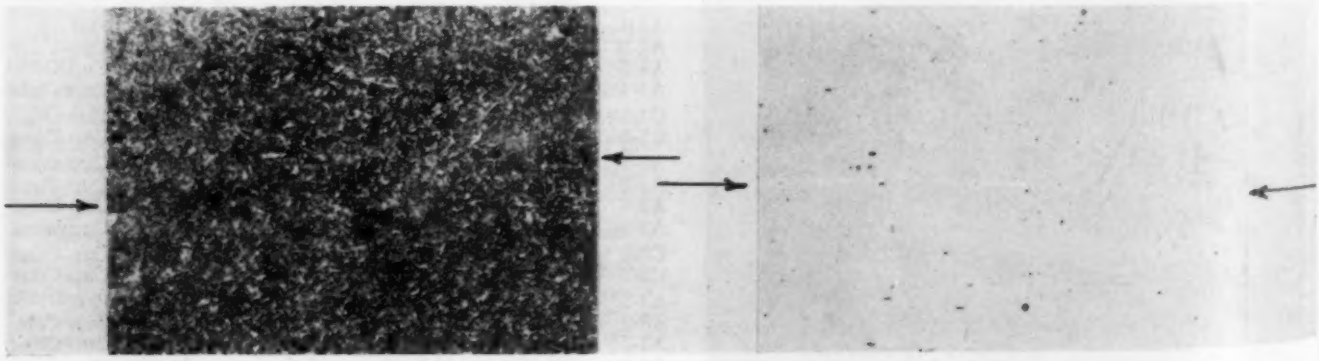
Fracture test coupons are included on both halves as a check on forging practice and quality of the heat treatment.[9] Specimens for micro examination are also taken from those test coupons to check the effectiveness of the carbon restoration treatment.

As no nondestructive test in common use is infallible for the inspection of pressure, flash, resistance or similar welds, a percentage of the assemblies are sectioned as a check on the welding procedure. These have been discussed in the section dealing with tests to determine weld quality.

Once a satisfactory weld cycle has been determined for a particular job, specific instructions are issued to operators concerning hydraulic and gas pressure setting, and the amount of total shortening. Close adherence to the established cycle is necessary to produce satisfactory parts.

Summary

The pressure-welding process has been successfully adapted to the manufacture of propeller barrels from S.A.E. 4345 steel forgings. A modification of the closed joint method employing a multiple pressure cycle was used and the welding technique was developed to the point where tensile and yield strengths through the weld were equivalent to those of the remainder of the barrel.



A B

Fig. 14—Typical Microstructures of Pressure Welds in S.A.E. 4345 Steel

A. Picral Etch
B. Oxygen Detecting Etch

Intimate contact of the abutting surfaces is essential throughout the welding operation and was maintained by insisting on a clean, flat and smooth surface grind; by relieving the holding dies to support the ends of the arms only, by coining the arms as a final forging operation and by using a high initial pressure for welding.

Close gas flow control was necessary to realize the best welding temperatures, and to effect reproduceability of results.

Experience has indicated that weld quality and dimensional stability was dependent upon the design of the equipment used.

A stress relief treatment was required immediately after welding to eliminate the formation of cracks upon cooling from welding. The weld upset had to be removed prior to heat treatment to prevent propagation of quench cracks from notches at the upsets.

A rigid system of quality control was installed to guarantee soundness of the assemblies throughout all stages of manufacture. Once a satisfactory weld cycle had been determined for a job, specific instructions were issued to operators, and the time cycle and amount of upset for each assembly welded were recorded and examined.

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Interpreting Teaching of Arc Welding from an Analysis of Motor Learning Studies

By Walter J. Brooking*

I. Importance of Study of the Learning Process in Industrial Vocational Subjects

THE importance of effective teaching of the manual skills associated with modern mechanized production is assuming an ever increasing importance because of its great economic and social significance in our present way of living. Theodore F. Struck[22] points out that an ever-increasing percentage of the American population earn their living by performing semiskilled and skilled manual processing in industrial production, and that the speed with which technological advances require the learning of new or related skills requires that an efficient and realistic type of education in these subjects be available for large numbers of industrial workman as well as young people who are potentially industrial employees and eventually will take their place as producers in manufacturing programs.

The trend toward providing realistic and practical industrial vocational education to an increasing number of our youth in the latter part of their school program prior to their entering industry has been pointed out by Eells[10] in his study of the junior college. Here he presents the fact that within the past 20 yr. the number of students who graduate from high school and enter into a period of from 1 to 2 yr. of education prior to entering industrial or other occupations has increased to almost a quarter of a million. The emphasis in the junior college program of education is strongly on "terminal" education which stresses occupational education. In many such programs approximately half of the enrolled students study manual, technical and related occupational subjects including oftentimes the manual skills which fit for industrial employment.

The providing of practical and realistic education in manual skills such as arc welding or machining has long been recognized as one of the most expensive offerings in the curriculum of schools because of the high cost of the machines and other mechanical equipment required, as well as the costly materials which are usually destroyed by the learner in the course of his learning exercises.

It is therefore especially important, in view of the growing trend in the presentation of trade and technical subjects, that a scientific knowledge of the learning process as it is related to the manual skills of industrial production be studied, analyzed and practiced to the end that the greatest amount of effective learning be accomplished within the shortest possible time, and with the minimum expenditure of time and materials.

One of the fields of training in industrial manual skills which is assuming increasing importance is that of training arc-welding operators to meet the demand of this growing method of industrial production.

It is a matter of common knowledge that many buildings, common machines and other items of equipment in everyday American use are being manufactured by the arc-welding method.

Much of the equipment and implements of war which won World War II were of arc-welded construction. The inherent advantages in the use of the process are causing increasing adoption of the method. This is described by the study by Jefferson,[19] Editor of *The Welding Engineer*, which shows that the equipment and materials alone which were used in arc welding in 1946 represented an investment of over $76,000,000. Had it not been for strikes and materials shortages which existed during that year, the normal usage would have been approximately $100,000,000. The same study indicates that the welding industry has increased in its scope and popularity over twice as rapidly as other industrial production as indicated by the Federal Reserve Board's report on all industrial production.

With this increase in adoption of the method, there must be a considerable program of training operators.

The minimum manual skill required in arc welding is one which enables the workman to strike, maintain and manipulate the welding arc in such way as to melt the metal electrode and the surfaces of the parts which are being joined by a progressive movement of the electrode along the joint as it melts in such way as to leave a sound deposit of weld metal which completely fuses the two pieces being joined. This process requires the entire attention of the operator while the electrode is being deposited and requires a practiced manual coordination between eye and hand which maintains the arc at proper length and provides the required manipulation to deposit a sound weld joint.

Since the metal is in the liquid condition as it is being deposited, the manipulation is important because the welding operator must use an electrode of the proper size and keep it moving as he deposits the weld metal rapidly enough to allow the metal to freeze in the proper contour and in the form to meet the requirement of a good welded joint without the metal flowing away from the joint by gravity. This problem is complicated by the fact that welding joints are often deposited with the joint in such a position that the plane of the weld is in the vertical position, so that the metal can flow downward away from the fused area; or in the overhead position so that it tends to drip downward away from the members of the joint being fused. Controlled and skilled manual

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dexterity are therefore required to control and manipulate the welding arc under these circumstances to provide a good looking and sound welded deposit.

II. Scope of the Present Study

This study is undertaken to obtain a better understanding of the learning process involved in training arc-welding operators with the view of criticizing and possibly improving present practice in such training.

The study is composed of four parts:

A. A presentation of the method used in training arc-welding operators by a large, progressive manufacturer of arc-welded equipment who has trained his own welding personnel for the past 12 yr.

B. Description of other welding operator training programs outlined in welding literature.

C. An analysis of the trade, psychological and educational literature covering the motor learning which may be applicable to the teaching or learning of the manual skills associated with arc-welding operation.

D. Evaluation of the present methods of teaching arc-welding operators in the light of the literature for the purpose of determining how to improve the teaching or learning process, or which need further study to indicate the procedure which would be most efficient in the learning or teaching of these skills.

III. Teaching Arc Welding in the R. G. LeTourneau Organization from 1935 Through 1947

Arc-welding operators have been taught in the LeTourneau organization since the Peoria, Ill., plant was started in 1935. This plant is a producer of heavy earth-moving machinery of completely arc-welded steel construction on a mass-production basis.

This organization early developed the mass-production method of arc-welded production using setting-up and weld positioning fixtures, together with standardized welding procedures for the production of each welded structure.

Early in 1935, it became apparent that it would best serve the interest of efficient production if the LeTourneau Co. would train its own welding operators, starting with men who knew nothing of arc welding rather than try to modify the past experience of the available arc-welding operators. The reasons for this decision were (*a*) that a large number of arc-welding operators were required, and (*b*) the available welding operators in the community had no experience in mass-production methods, and therefore required almost as much training as completely new men.

The basic skill to be learned included the elementary operation of a flame-cutting oxyacetylene torch (a rather minor portion of the program), and the ability to arc weld steel structures using jigs and fixtures.

While most of the welding was done in the down-hand position (in the form where gravity aids the welding operator in depositing the metal), a small amount was done in the horizontal, vertical and overhead positions. The quality of the weld deposit was of a class somewhat less exacting than is required for the welding on boilers and other pressure vessels, but was required to be of good appearance, and dependably sound deposition.

A training program was established in the summer of 1935 and has been continued and modified to the present program which is being taught in the LeTourneau Technical Institute at Longview, Tex. An examination of the method of teaching and a plan of the course at three different stages in its development follows:

A. Original Arc-Welding Operator Training Program Started in 1935

The original program in 1935 consisted of employing men who knew nothing of arc welding and placing them in training with pay while learning. Selection was on a basis of passing a physical examination and an expressed desire on their part to learn to become an arc-welding operator.

The training began the first day when they went to work in a portion of the shop set aside for a training department. Welding machines and scrap steel were available.

The student began by being told and shown the use of an electrode holder, an electrode, a welding machine, and the tools which he required, including a slag-removing hammer, a wire brush, welding sleeves to protect his arms and wrists from sparks and the welding hood.

A full-time instructor described these items to him, and showed him how to start and stop the machine, how to adjust it, and then had him begin to learn to strike and hold a welding arc. Thus he began to learn the elements of depositing a simple bead weld (a continuous deposit of weld metal).

The program of instruction which followed was one of almost continuous practice for a full 9 hr. a day and half day on Saturday (50-hr. week) under the attention of the instructor at actual welding practice, depositing weld metal on scrap.

Striking and holding an arc and the deposition of a simple bead weld preceded the practice of joining together pieces of scrap in different types of joints, in flat or down-hand position.

As soon as the student became somewhat proficient in depositing a simple down-hand weld he began to learn the elements of the horizontal fillet, vertical and overhead position welding, and to practice them each day.

Toward the end of his training period, he was given some instruction in the use of a flame-cutting oxyacetylene torch. He adjusted the torch, learned to light it and to turn it off; and to use it to flame cut pieces of steel to the shape and size that he wanted.

The entire training program lasted from 5 to 7 wk. (250 to 350 hr. of practice) depending upon the student's aptitude as shown by his ability to deposit welded joints which would be satisfactory for the simplest production work done in the LeTourneau Corp. factory. At this stage in his training, he then was transferred to the factory where he started production work on a 50-hr.-a-week basis. Supplementary instruction by a roving welding instructor assisted him in getting acquainted with the jigs and fixtures which were in use, assisted him in learning to read blueprints, and follow the procedures for setting up and welding the structures.

B. Plan of Instruction at the LeTourneau Peoria Plant in 1941

Continued growth in the Peoria Plant from 1935 to 1941 maintained an almost continuous program of training welding operators.

In 1941 the training process had changed somewhat as indicated by the comprehensive account published in THE WELDING JOURNAL in March 1941, written by Isgren and Brooking.[18]

The trainees were selected in about the same way, except that in addition to a physical examination and an interview, an intelligence test and mechanical aptitude test (a nonstandard test introduced into the company's program by an industrial engineer in 1940) were used to aid in selecting the trainee.

An 8-hr. day and a 44-hr. week constituted the work period.

The trainee began his training in much the same way as in the original course, and the details and sequence of his training were much the same as in the original course in 1935.

The instructors, some of whom have had 4 to 5 yr. experience, probably used better teaching methods in instructing the trainees throughout their period of learning.

More attention was paid to the theoretical side of arc welding than in the original course. A series of home study course lessons, based on a textbook which provided some elementary blueprint reading and some elementary theory of arc welding stressing vocabulary and terminology was a part of the course. The last eight lessons presented the arc-welding symbols control information which allowed the operator to interpret the welding instructions and specifications and the company's blueprints for each welded structure.

The instruction in theory was primarily a home study project in which lesson sheets were filled out based on reading the text and brought back to the welding instructor. Short class periods of group instruction in theory were held, however, during the period of instruction amounting to about 1 hr. a day. The rest of the 7 hr. (broken by a 1-hr. noon period) were devoted to supervised practice in manipulation of the arc and the use of various types and sizes of welding electrodes and making various sizes and positions of welds.

The objectives required of this course were the same as in the original course, except for the additional theory, and 5 to 7 weeks, depending upon the operator's ability, were required for the trainee to qualify for work in the factory. As in the first course, the student was paid for his learning time.

A total of 200 to 250 hr. of practice, while 30 to 40 hr. were devoted to theory in group instruction, were required for the course. The elapsed time from beginning to end of the course was as long as the original plan, but the actual hours of practice were reduced in the 1941 plan.

Shortly after the publication of the account of the program as it was in 1941, the method of training was further studied and revised to include more group instruction in welding theory and less hours of practice.

A series of moving picture films with sound and color had been produced by the General Electric Co. and they were incorporated into the training program as a part of the theory in lieu of practice.

The use of the films and group discussion, the time for which was taken from the continuous practice program, proved to be effective in the ultimate utilization of the visual aids at the expense of the practice as is shown in the plan for training welding operators established in the LeTourneau Technical Institute which is described in the next section.

C. *The LeTourneau Technical Institute Welding Operator Training Program (Vestibule Training Period)*

The objective of the vestibule training period in the LeTourneau Technical Institute's course of arc-welding instruction serves the same purpose as the course of training described in each of the two preceding sections, that of providing the students with sufficient manual skill and understanding to perform passable work in the simple production jobs in the LeTourneau Corp.'s plant.

The student, while he is taking the course, is a full-time student of the LeTourneau Technical Institute. The arc welding is a part of his shop training which carries recognized school credit. His pay starts as soon as he enters the LeTourneau Corp.'s plant at the end of the 3-wk. vestibule training program.

A detailed outline of the course of instruction for those 3 wk., which is the equivalent of the previous two outlined programs, is given in the following outline:

Laboratory Schedule of Work Processes and Approximate Hours Required for Arc Welding Vestibule Training

	First Week	**Hr.**
1st day	General Instruction	2
	Arc Welding	
	1. Safety precautions	
	2. Care of tools and equipment	
	3. Operation of equipment	
	4. Adjustment of machine	
	5. Preparation of material for welding	
	6. Making the weld	
	Practice Making Bead Welds on Flat Plate	3
2nd day	General Instruction	2
	Acetylene	
	1. Safety	
	2. Care and operation of equipment	
	3. Mounting regulators on cylinder	
	4. Operation of regulators	
	5. Preparation of material for weld	
	6. Welding procedure	
	7. Cutting (Oxyacetylene)	
	Practice Making Weave Bead on Flat Plate (Arc)	3
3rd day	Flat Position Welds (Arc)	3
	Torch Cutting (Oxyacetylene)	1
	Oxyacetylene Welding (Ferrous Metals)	1
4th day	Multiple Pass Welds in Fillet Position (Arc)	3
	Torch Cutting (Oxyacetylene)	1
	Oxyacetylene Welding (Ferrous Metals)	1
5th day	Multiple Pass Welds in Fillet Position (Arc)	3
	Horizontal Padding (Arc)	
	Horizontal Fillets (Arc)	
	Torch Cutting	1
	Oxyacetylene Welding (Ferrous Metals)	1
	Second Week	
6th day	Semivertical Position of Welds (Arc)	3
	Torch Cutting	1
	Oxyacetylene Bronze Brazing and Welding	1
7th day	Semivertical and Vertical Positions of Welds (Arc)	3
	Torch Cutting	1
	Oxyacetylene Bronze Welding	1
8th day	Vertical Position (Arc)	3
9th day	Vertical Position (Arc)	3
	Torch Cutting	1
	Oxyacetylene Brazing and Welding	1
10th day	Overhead Position	5
	Third Week	
11th day	Corner Welds $^3/_{16}$ and $^1/_4$ #77	3
	Oxyacetylene Welding and Brazing	1
	Torch Cutting	1
12th day	Flat Fillet $^1/_4$ #77 or $^1/_4$ #LT or 88	3
	Oxyacetylene Welding	1
	Torch Cutting	1
13th day	Horizontal Fillet (Arc)	3
	Aluminum Welding (Gas)	2
14th day	Corner-Flat-Horizontal Welds	3
	Aluminum	2
15th day	Examinations	3

During the same period, the theory as outlined below is given as a 1-hr.-per-day classroom course of study parallel to the laboratory work in the vestibule training shop.

Welding Theory—Metallic Arc Welding
(Vestibule Training Complete in 3 Wk.)

1. Introduction
2. Striking the Arc
   Also Film: "The Inside of Arc Welding Fundamentals"
3. Safety Precautions
4. Cardinal Don'ts
   Also Film: "The Inside of Arc Welding Flat Position"
5. Bead Welds Flat
6. Weave Beads
   Also Film: "The Inside of Arc Welding Horizontal Position"
7. Fillet (horizontal) One Pass

8. Fillet (horizontal) Two Pass
9. Fillet (horizontal) Multiple Pass
   Also Film: "The Inside of Arc Welding Flat and Horizontal"
10. Fillet (horizontal) Lap Position
11. Definitions
12. Groove Weld Flat
13. Definitions
14. Fillet Flat Corner Weld
15. Definitions
    Also Film: "The Inside of Arc Welding Vertical Position"
16. Fillet Vertical Corner Weld (Bottom to Top)
17. Fillet Corner Weld Horizontal
18. Semivertical Weld Tee Joint
    Also Film: "The Inside of Arc Welding Overhead Position"
19. Fillet Vertical (Top to Bottom)
    Also Film: "Why There Is No Arc Blow in A.-C. Welding"
20. Shielded Arc Electrodes of R. G. LeTourneau, Inc.
    Also Film: "Why There Is No Arc Blow in A.-C. Welding"
21. Arc-Welding Equipment
22. Welding Operators Equipment

The moving pictures are 16-mm. sound pictures—11 min. long with exception of the last one. All are shown during the Vestibule Training Period.

The welding theory as it is provided in the 3 wk. of the vestibule training consists of written lesson sheets, lectures, discussion and the showing of the moving pictures listed in the foregoing outline.

The moving pictures are shown during the class period, and are repeated with discussion from the class and interpretation by the instructor at the time that they are shown.

Most of the time spent in the vestibule training laboratory is manual practice under supervision of the instructor. None of the manual practice is conducted continuously for a period of more than 3 hr. except on the tenth day when the practice in the overhead position becomes the entire lesson.

Torch cutting with the oxyacetylene torch and some practice of manual oxyacetylene welding comprises a part of the practice for 8 out of the 15 days of vestibule training work.

The last two days of the vestibule training period are devoted to a consideration of aluminum welding (which is in addition to the content of the previous courses and serves as an introduction to nonferrous welding, both with the arc and by gas).

An analysis of the 3-wk. training period indicates that the actual practice in arc welding and cutting with the acetylene torch corresponding to the previous courses of instruction requires a total of approximately 48 to 50 hr. of manual practice plus approximately 15 hr. of welding theory in organized class work. There has been added approximately 20 hr. of manual instruction in the related subjects not covered in the original training courses, but in which it is important for a well-trained welding operator to have had some experience and practice.

In addition to the class in welding theory, three or four college level classes, usually English, Mechanical Drawing and a college course in mathematics, are studied by the student while he is in vestibule training. Under this program, totaling approximately 85 hr. of work and welding study, he is more than the equivalent of the trainee of the other courses.

D. Other Welding Operator Training Programs

The *Welding Handbook*,[37] which is the official handbook of the AMERICAN WELDING SOCIETY discusses an arc-welding operator training program leading to employability in simple welding. The time required is 6 to 8 wk. of training, the most of which is continuous practice on making simple welds in the flat horizontal fillet, horizontal, vertical and overhead positions in the presence of an instructor. A study of some theory as group discussion for varying intervals sparsely distributed throughout the training period is indicated. Apparently between 200 and 300 hr. are required under this plan before the student undertakes production work.

Chaffee,[6] in his textbook for the training of welders in the trade school established by a manufacturer of welding materials and equipment, states that the length of the course is 5 wk. a total of 400 hr. in length, 350 hr. of which are welding practice in the presence of an instructor. The practice periods are 4 hr. in the morning with 1 hr. devoted to classroom instruction in theory, either the first, second, third or fourth hour, depending upon the convenience of the instructor; and a solid 4 hr. of practice in the afternoon.

The objectives and content of the course are almost exactly the same as those previously described.

Sacks,[28] in his textbook for a course of arc-welding instruction presenting the content for the same objectives as those described above, states that approximately 420 hr. of instruction are required to complete the entire course, although by the elimination of certain content and studying specifically on the knowledge and skill required to pass the No. 1 Navy test (all-position arc welding) that the average student can master it in approximately 300 hr. He recommends short group instruction periods, and strenuous practice periods under instruction. He also recommends the use of organized display of fixtures, charts, prints, etc., for the instruction of theory during the short groups instruction sessions.

IV. Analysis of Literature on and Related to Motor Learning

The analysis of literature on the learning of motor skill and related literature will be presented for the purpose of organization under subheadings in the following paragraphs:

A. Testing and Selection of Students on the Basis of Motor Educability

The first step toward an ideal training program involving manual skill (such as arc welding) would be to separate those who are most capable of learning manual skills to the required degree of proficiency from those who cannot. An analysis of the testing for motor educability and some related qualities and characteristics was undertaken.

Two studies were found on the effect of age upon the ability to learn manual skills. One by Thorndike[33] on the ability of people over 30 yr. of age to learn typing and shorthand showed that adults over 30 learn both typing and shorthand at a rate equal to 97% of the speed of 17- to 19-yr.-old students (rated at 100%).

A study by Ruch[26] indicates that adults from 34 to 59 yr. learn manual skills almost as rapidly as those from 12 to 17, and that those 60 to 82 yr. are somewhat slower in learning than the other two groups. Results showed that older people's learning parallels the prediction that operations calling for the greatest reorganization of the mental and motor processes required the longest time to learn. This may partially account for the early observation in the LeTourneau organization's training program that it was difficult to change habits of workmanship which some semiskilled welders had, and as a result that it was as easy to train a person who knew nothing of arc welding from the beginning as to modify the habits and training of already semiskilled welding operators.

Four studies reporting the use of motor skill tests as a means of predicting the ability to learn manual skills were found. Adams and Walker,[1] who used the Stanford

motor skills unit of six tests to measure the predictable proficiency of students studying typing concluded that the tests showed no reliability as a prediction of the possible proficiency of the students. Two studies by Brace,[4,5] using tests which measured the athletic ability of students in high school, indicated that the tests given (the Brace test and the Stout test) seemed to measure athletic ability which may have been obtained from previous experience rather than the ability to learn manual or motor skills. A study along similar lines by Espenschade[11] arrived at the same general conclusion as Brace; namely, that the Brace test did test motor ability but not the ability to learn motor skills.

A study by Kulcinski[21] led to the positive conclusion that the relationship between intelligence as measured by the I.Q. and the ability to learn muscular skills is related, the superior groups learning significantly faster than the normal group learning significantly faster than those with a subnormal I.Q. Caution must be exercised in the interpretation of this study in view of the fact that intelligence tests stated entirely as an I.Q. are valid only for ages under the lower twenties. However, it seems probable that other intelligence tests probably would give some indication that those with the higher rating would be able to learn muscular skills more rapidly than those with an average or lower than average rating.

Since arc welding requires that the workman be confined to a specific work station with restricted possibilities for variety of movement and diversification of attention, a study by Hovey[16] on whether individuals with an extroverted character were more subject to distraction by loud noises or other distractions which tended to divide their attention than introverts, was considered of some significance. The results of the study indicated that there was no significant difference between extroverts and introverts as affected by distraction.

Shartle[29] reports a study of a group of tests which would predict the ability of aircraft riveter trainees, assuming that some would be more dexterous and would learn aircraft-riveting operations more easily than others. Of 16 tests, three were finally selected as statistically and practically most sound. They consisted of a peg board apparatus, a worker's analysis finger dexterity apparatus and a finger-copying test. These tests showed that trainees who rated among the top third of the group performed 26% better than the lower third.

He also reported the use of a series of simple welds of varying quality as a rating scale for checking prospective welders who had already learned some arc-welding skill as it applied to shipyard welding. The matching of the sample weld which was made by the operator with the series indicated the welder's proficiency. This type of test is not a test predicting the ability of the welder to learn, but rather an evaluating criterion of his already mastered skill. This type of test has been in regular use in the LeTourneau organization and has been found to be of some value, although it is by no means infallible, since the welder may be out of practice or may be unable to perform at his best under test conditions because of nervousness or apprehension at the outcome of the test.

B. Fundamental Nature of Motor Skill Learning

In discussing the nature of motor learning, Griffith[14] and Woodworth[39] and Thorndike[34] all indicate that the fundamental learning process for manual skill primarily consists of the learner comprehending the individual physical motions required to perform a single operation, followed by the first actual performance of the individual motions in the operation by the learner, then perfecting by repetition of the motions of the operation until the successive motions may be done easily and, to a greater or lesser degree, without conscious mental direction of the body to perform each of the separate motions required.

The extent to which the motions became automatic in the mastering of a skill may be indicated by a study by Hunter[17] describing the process by which a white rat experimentally learns to run through complex runs or mazes. Hunter concludes from his study that the repeated running of a maze by a white rat finally results in his being able to start at the beginning and go to the end of the complex run without making mistakes and with a minimum of use of his higher mental processes requiring interpretation of his senses of sight, smell and hearing; and that his responses which cause him to change his direction in the run come as an almost automatic pattern of movements.

A study by Beck[3] shows that human beings form almost the same type of responses as the rats reported by Hunter with regard to learning patterns of muscular responses which occur automatically without conscious mental direction (conditioned responses).

Two studies which analyzed the nature of skilled movements, one by Hartson[15] and one by Cohen and Strauss[8] attempted to analyze the difference between the mechanics of the motions of workmen who exhibit various degrees of skill in performing the same operation. Hartson concluded that the more skilled workmen tended to perfect motions which were mechanically more efficient and less energy consuming, based on use of gravity, motion in one direction without having to make a counterbalancing motion, and use of a rhythmical form or series of motions, than those with less skill. Hartson indicated that where speed is a consideration, the skilled workman who can do his work with a generally relaxed body probably will do more accurate and better work.

Cohen and Strauss[8] studied the process of folding 18- x 18-in. sheets to 4- x 4-in. size 23 full-time entirely trained female workers. Moving pictures were made using a standard 16-frame-per-second camera, and the pictures were studied by micromotion methods. The time required ranged from 145 frames, the slowest, to 48 frames, the fastest. The number of basic motions required per cycle varied from 41.7 for the slowest compared to 21.8 for the fastest. The conclusion reached was that two operators may perform with the same general method, but the more skilled will perform a much better detailed method. The skill and the method may be considered independent, but varying skilled operators using the same general method will show varying basic operations, such as lifting, grasping, starting, stopping and moving, the most skilled ones showing the best or most simplified basic motions. The authors concluded that some workers have the ability to eliminate waste motion in basic operations in a process and others probably cannot. No method of measuring this ability was presented.

The importance of Hartson's and Cohen's analyses of skilled motion as related to arc welding must be interpreted in the light of the fact that while an arc welder is depositing melted weld metal, he must be able to manipulate it rapidly and with minute precision for the period required to burn an electrode (75 to 120 sec.). Since the day's work for some welding operators consists of 60 to 65% of this type of confining and exacting activity, the ability to relax and eliminate lost motion is a very important attribute for the skilled welder if he would maintain high quality work without excessive fatigue.

C. The Learning Curve and the Effect of Practice

Thorndike,[34] in his studies of learning motor skills, described the learning process in the form of a graphic

curve, an example of which was shown by students learning typing by the touch method.

The curve may be described as starting with a low degree of efficiency when the motions of the process are being first learned. During the first few days of practice, the increase in proficiency is rapid, and then for each successive period of practice, the amount of rise in proficiency becomes less and less noticeable until a large amount of practice is required to produce a given increment of increase in skill. During the progress of the curve, there are sometimes periods when the proficiency, as indicated by the number of strokes or the number of words typed, remains almost constant or even becomes less than the previous practice score. These periods were called plateaus of learning by Thorndike, and seem to be a period when subconscious habits of motion are being formed but are not perfected and combined to provide a higher degree of proficiency. Apparently this plateau merges into a rise of efficiency when these patterns of habit are formed and combined into more efficient movements or more rapid subconscious mental responses.

Four studies were found which dealt with the effect of varying amounts of practice and varying the length of practice period in learning manual skills. One by Lorge[22] analyzed the effect of continued practice without interruption for a given length of time compared to practicing the same motions for short periods of time with a varying interval of rest or diversified activity between the practice periods. He concluded that learning is aided by spacing relatively short practice periods throughout the entire learning process and that the learning process is aided by the spacing, most of the beginning and least at the end of the learning curve following the same general pattern as the form of the learning curve itself.

Snoddy[31] experimented with groups of learners by having them trace figures using mirrors which reversed the natural response needed to trace accurately. He had one group make 20 mass practice (without interruption practice) drawings, had another group make 20 practice tracings with 1 min. of nonpractice between each, and a third group make 20 tracings with one day of nonpractice intervals between each. The results of his study indicated that the one-day interval of distributed practice allowed the learning of the skill almost twice as fast as the mass practice, without any interval of work between the 20 tracings; and that the 1-min. interval allowed learning about one and one-half times as fast as the mass practice method.

A study by Ruch[27] on the same type of problem resulted in conclusions generally agreeing with those of Lorge and Snoddy.

A report by Smith[30] stresses the importance of practice effort constructively criticized and guided by the instructor in learning manual industrial skills (such as arc welding). He points out the natural desire of students to "do something else" may be a response to a learning curve plateau due to the mastery of the mechanics of the motions of the skill, but not sufficient interest nor practice to perfect the improvement which leads to mature proficiency. He does not indicate whether he thinks the practice should be massed or distributed (spaced) practice, but does indicate that the repetitive practicing of the motions involved in the skill are required to form and perfect the habits, responses and motions necessary in the mastery of the skill.

Three studies were found reporting investigation into the result of learning and practicing work related to or similar to a specific manual skill to determine if practice in one could be transferred as skill into the other.

One by Christenson[7] discusses this transfer of training as applied to part-time vocational work study programs in high schools and junior colleges, especially those jobs involving manual skill. He points out that the more realistic and specific the training and practice, the more useful it is to the student when he goes on a production job. He also shows that only where there is a relatively close relationship between the motions and operations performed and only when that relationship is pointed out to the learner while he learns them, is there any appreciable transfer of the value of practicing one in the performance of the other. Therefore, the instruction program must teach, as nearly as possible, the specific conditions and operations required on the job.

A study from Noble[25] showed that there was no transfer of training from students who practiced basketball shooting from the side of the basketball floor within a few feet of the basket, and the shooting of free throws from the foul line.

Frisby[13] describes the use of a "landing trainer" machine which simulates landing conditions in the training of airplane pilots in England during the war. The mastery of the process of landing seemed to be the most difficult, and the machine in which students could be given practice resembling the landing of the plane was built. It was determined that $2^1/_2$ hr. of training in the landing trainer machine after the pilots had learned to take off and fly the plane (but not to land it) significantly reduced the length of time required before the pilot was able to solo and was therefore a trained pilot. In this case, the practice training was effective because the trainer was built to almost exactly duplicate the motions and conditions of landing the plane. The assumption from the results of these tests follows that the training process and practice efforts for beginning arc welders should be as realistic as possible including duplication of the actual operations necessary for the production welder under conditions as nearly like real production welding as possible.

D. Interest, Attention, Readiness and Motivation

Walton[36] states that one of the most important elements in learning a skill is to be able to keep the progress of the man's learning before him. It helps him to maintain interest if he can see graphic results of his progress toward proficiency and gives him a desire to "beat his record" with attendant satisfaction upon his success. This effort tends to shorten or avoid plateaus of learning as he masters the skill.

A study by Fiske[12] illustrates the desirability of keeping the student's progress before him by reporting the experience of aviation gunnery practice students when he stated "the group pointed out that the student learning and motivation both suffered if their hits and misses were not always reported to them as soon after firing as possible." In a somewhat similar report, Wolfle[38] summarized the useful devices or steps in the training of military personnel in manual skills as follows:

1. Improved distribution of practice. He cited a case where a 7-hr.-a day mass practice on radio code was reduced to 4 hr. a day with equal results.
2. Secure active participation of the trainee. They learn to do by doing.
3. Vary the practice material, because to practice the the same thing with variety of material aids interest.
4. Provide accurate performance record so the learner may have immediately, knowledge of the results of their practice.
5. Write clear detailed plans for the instructor, better to define objectives and method of study.

Davies[9] made a study of the effect of instruction upon the process of learning a complex motor skill by having groups of students practice archery in a gymnasium 50 min. per day, two days a week, for 3 mos. One group received specific instruction throughout the practice period, and a second group received none. Those who received instruction showed a very significant difference in their final scores compared to those who did not. Davies concluded that the instructor cannot completely eliminate learning plateaus or dips in the learning curve, but that the able instructor helps the student to break up faulty techniques before the technique becomes a set habit early in the learning process.

The value of realistic and genuine practice in the learning of certain motor skills is reported in a study by Mason[23] who quotes the instructor in charge of the electrical department of the Rochester Institute of Technology as saying that students on the cooperative plan (those who work as part-time employees at actual electrical production problems of motor winding, repair and maintenance part time and go to school part time) seem to learn about as much in 5 mos. of study as students in the same course but not on the cooperative plan (working in school laboratories) learn in 7 mos. He attributed this to a more serious purpose as a result of the real work experience. The motivation of the students by the realistic end use of his learning efforts apparently caused better interest and more attentive practice.

In the learning process the sequence of operations presented to the student must be such that the student is ready and able to perform the motions required in the learning of the motor skill. This is stressed strongly by Allen[2] who shows the part of the instructor in employing suggestion of related thoughts or actions to the learner which brings him to the threshold of the new unit. It readies the learner's mind by interest and consciousness of the ideas or facts to which the new unit is related and can be associated. He must be physically able to do the process required in the new learning unit. The significance of this with reference to the teaching of arc welding may be stated simply as follows:

"Skills upon which later learning units must be based, must be learned first. For example, a student must be able to strike, hold and manipulate a welding arc before he can deposit a weld in the overhead or vertical position."

E. Visual Aids and Motor Learning

The extent to which visual aids, especially sound moving pictures, may be used to provide variety, and possibly to shorten the hours of practice in the learning of manual skill, was investigated. It was considered especially important in view of the fact that there are several moving pictures available for use in training welding operators.

A study reported by May[24] states that the learning from demonstration films is either immediate or delayed imitation, usually the latter. He points out that the learner must have the ability to perform certain basic skills necessary to perform the imitation before he can learn by this means. Teachers, in using film, should analyze every unit in the lesson, and emphasize them before and after showing the film. Repetition of showing the film is often helpful. He states that in teaching manual skills, learning is often by trial and error with instructions and demonstrations from the teacher. Here the film is a real aid in showing a wide variety of skills and operations beyond those possible of duplication in the training program or in the school.

Krawiec[20] made a study of the comparison of learning and retaining of materials presented visually and by sound. He concluded that the learning process was aided most by visual presentation, although for the purpose of recalling something learned previously, the auditory (sound) presentation seemed to have some real value. This study might indicate that a skillfully constructed sound motion picture film would be the most effective combination for teaching manual and related skills.

A highly suggestive study is reported by Vandell[25] on the effect of mental practice in the acquisition of motor skills. He selected the students for this test and by means of standardized tests divided them into three equated groups.

Group 1 threw darts and basketball "free throws" each day for 20 days. Group 2 did the same as the first group on the first day and on the 20th day without practice during the intervening period. Group 3 did the same as groups 1 and 2 did on the first day and mentally practiced by imagining that they were going through the motions of throwing darts and making basketball "free throws" each successive day for a half hour until the 20th day and then performed the actual processes on the 20th day.

The results of the test showed that Group 2, who did not practice, had not improved over their first day's scores. Group 1, who had practiced, attained the highest scores and showed considerable progress on the learning curve. Group 3, the group which mentally imagined they were practicing the operations, also showed a significant improvement, over two-thirds the progress shown by the group who actually practiced each day.

One student in the group which mentally practiced (Group 3) failed to gain and also was found to have completely failed the visualization portion of the standardized intelligence test, indicating that the ability mentally to visualize is essential for learning by mental (imaginary) practice.

This study by Vanzell strongly suggests that the use of well-constructed visual aids in the form of moving pictures of specific operations may have a greater value than might be indicated by the two previous studies cited. Well-planned films may include a mental practicing element which, though less effective than the actual physical practice, may add significantly to the learning process by a strictly practice effect, in addition to providing detailed descriptions and demonstrations of complex techniques.

This study may also offer some suggestion as to why the exceptional student who is motivated by a consuming interest in some motor learning process may far surpass the rate of learning of some less interested student because of the mental rehearsal of the motions and process while he is not actually practicing them physically.

V. Application of Research Findings to Teaching Arc Welding

The analysis of the welding operator training course preparatory to the operator assuming production work shows that the original plan followed by the LeTourneau Co. and the plan followed by that company in 1941, as well as three other plans cited (not including LeTourneau Technical Institute plan), depended basically upon long hours of massed practice in the elementary skill of holding and manipulating an electric arc and depositing welds in the various commonly occurring positions of weld deposition. Short periods of instruction in the related theory using charts, prints and samples were characteristic of most of these plans. The time required for training the average operator from the start ranged from approximately 200 hr. to something over 300 hr. Constant

instruction from an instructor is characteristic of each of these plans.

The plan followed by the LeTourneau Technical Institute differs from the foregoing plans in that the use of distributed practice, visual aids and a greater variety of manual sk lls (including acetylene welding and some welding on aluminum) than the other courses indicates a somewhat different approach to the learning problem.

The fact that the learning process requires approximately 72 hr. of manual practice on all of the subject matter presented plus 15 hr. of related theory as classroom instruction, a total of about 85 hr., seems to indicate that the learning process may be facilitated by distributed practice and the use of sound motion pictures in arc-welding instruction.

It is difficult to state with certainty that the end product of each of these courses is exactly the same, but it can be stated with certainty that the student of LeTourneau Technical Institute at the end of 3 wk.'s elapsed time is the equivalent of the original LeTourneau Co.'s plan requiring approximately 6 wk. with some 200 hr. of manual practice.

The shorter term required to accomplish the objectives in the LeTourneau Technical Institute's plan seems probably to be accounted for by the previously cited literature, showing the effectiveness of distributed practice over mass practice; the usefulness of visual aids to shorten or avoid learning plateaus by providing clearer demonstrations of techniques, possibly a certain amount of mental practice; and the beneficial effects of a variation in the presentation of the practice materials.

The necessity of providing a strong incentive for the student to learn effectively is stressed throughout the literature cited. It is also shown that the practice during the learning process should be done on work and under conditions which most nearly simulate that of the production job to which the student will go. Perhaps one reason that the LeTourneau Technical Institute's program effectively shortens the period of learning may be that the student who is enrolled as a student under a cooperative plan learns to become a minimum arc welder without pay and knows that at the end of his 3 wks.' training period, if he succeeds, that he will be placed as a part-time paid employee in the LeTourneau Corp. Factory as the laboratory for his course of study in the LeTourneau Technical Institute. He also knows that if he fails, he probably will be dropped from school. In the earlier training plans of the LeTourneau Corp., the learners were paid for their practice time, an element which may have reduced their interest and motivation in the learning process. In the other courses cited, the students may not know exactly where they will work or what conditions they must meet, and therefore, the training program may not seem as vividly interesting to them as in the LeTourneau Technical Institute program.

Two important elements borne out in the literature apparently cannot be reflected to the maximum degree in the welding instruction programs described.

One of these is the use of intelligence tests, especially tests which indicate whether or not a learner can perfect his motions in the learning of a skill to eliminate waste motions, and to establish the movement in a given skill to the extent that they become subconscious habits. The literature does not indicate that such tests are available, but if they were, it would greatly aid in guiding and selecting prospective learners of arc welding. The use of intelligence tests in the LeTourneau program of 1941 and the LeTourneau Technical Institute program probably account for some of the relatively less time required for the training process than in the other cases cited. However, it is probable that much greater value could be realized from tests if better tests were available.

The second important element is that there is no definite indication that the maximum efficiency in the use of either the distribution of practice in the learning process or the use of properly constructed visual aids is being exploited to the best advantage. It is apparent from the literature that the material studied must be well organized and must come in a sequence which provides the basic skills first, but it is probable that even better illustration of these basic skills and variety of practice material presented in good training films shown between real practice periods can effect a greater economy in length of time required for training.

The statement that there is little if any transfer of training in skilled work, not related to arc welding, indicates that the selection of workmen skilled in trade other than welding would not indicate that they would succeed as arc welders.

It appears that the age limit for learning arc-welding operators is no less than the usual age limits of employability, and that age alone need not deter a training program from including older men.

VI. Summary and Conclusions

As a result of the foregoing description of arc-welding operator courses and analysis of the literature pertaining to the teaching of manual skills as they relate themselves to the teaching or learning of the basic skills necessary to be a minimum arc welder who is employable on production work, the following conclusions are presented:

A. The selection of prospective students with a high degree of intelligence probably would indicate that they would be able to learn arc-welding skills more rapidly than those who have average or below average intelligence.

B. The prospective learner must be interested in arc welding and must have a desire and a willingness to undergo a period of formal instruction, including manual practice and related theory, if he would succeed in the course.

C. The presentation of the course of instruction must be in such sequence that the learners master the basic skill such as striking, holding and manipulating an arc before he can visualize or practice depositing welds in the various positions of welding. The deposition of weld in the flat position should precede the vertical and overhead positions because of the relatively more complicated and difficult motor responses required in the latter.

D. The learning process in arc welding may be accomplished with fewer hours of manual practice if spaced or distributed practice periods are included in the plan rather than following a massed practice plan.

E. The use of a variety of practice materials, so long as they are closely related to the specific motions and processes being studied will probably shorten the learning period. It is suggested that variety in the size and types of welding electrodes, and variety in the form of welded joints in a given position may provide variety; the value of which is reflected in maintaining and encouraging a greater interest on the part of the student.

F. The use of sound moving picture films related to arc welding describing the learning of arc-welding processes may be used to materially reduce the hours of manual practice in the learning of arc-welding operations.

It is believed that further study which might result in a useful development in two areas would be profitable:

A. Development of a test which would measure the

ability to learn motor skills with a high degree of reliability and which could be easily administered and scored.

B. The development of better sound motion pictures which would scientifically incorporate mental practice, as well as demonstration, in teaching arc welding.

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Cleavage Fracture of Ship Plates as Influenced by Size Effect, by *Wilbur M. Wilson, Robert A. Hechtman and Walter H. Bruckner*

New Developments in Railroad Maintenance-of-Way Work, by *C. A. Daley*

New Applications of Inert-Arc Welding, by *R. W. Tuthill*

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Welding of Locomotive Type High Pressure Boilers*

By George M. Trefts, 3rd†

THE locomotive type boiler is one of the oldest and best known types of steam generators. It supplied steam to drive most of the earliest locomotives some 120 yr. ago and has been used for that purpose ever since. The same type of boiler has found wide use on other moving equipment such as threshing machines, road building equipment and particularly in the oil fields to supply steam for the drilling of oil wells. This paper deals with the construction of oil field boilers. The general features are shown in Fig. 1.

Like all locomotive type boilers it has an internal firebox surrounded with water on top and sides. The firebox is held with staybolts to an outside casing and this part connects to a shell or barrel containing a number of tubes or flues which end into a smokebox with outlet for the stack.

It is a self-contained unit that can be set up quickly and moved around easily. Besides, it generates steam rather quickly and in good volume for heavy peak loads. These features made this type of boiler popular in the oil fields since the earliest days and it has held its place there ever since.

* Presented at the Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† Farrar & Trefts, Inc., Buffalo, N. Y.

In the early history of the oil fields one small boiler of 15 to 25 hp. supplied all the steam needed for the machinery then in use. Nowadays five or six boilers of 150 hp. each may be seen on the heaviest drilling rigs. Four of these in a battery is a common sight. A battery of 5 boilers in field is shown in Fig. 2.

The customary working pressure is now 350 psi. although some boilers of 500 psi. working pressure are in use. Some of these boilers have a built-in superheater, the same type as used on railroad locomotives.

Up to about 12 yr. ago all these oil field boilers were built of riveted construction. With working pressures getting higher all the time and under the severe conditions of oil field use these riveted boilers needed a great deal of upkeep on the joints and now and then a bad case of caustic embrittlement between rivetholes on the longitudinal barrel joints would show up. To do away with this danger we started building boilers with a welded barrel as a first step.

The barrel end of this boiler was welded, X-rayed and stress relieved, then riveted to the firebox end and this first step in welding found immediately a warm reception among boiler users (Fig. 3).

Encouraged by this reception, we proceeded to eliminate other riveted joints step by step. Several of these

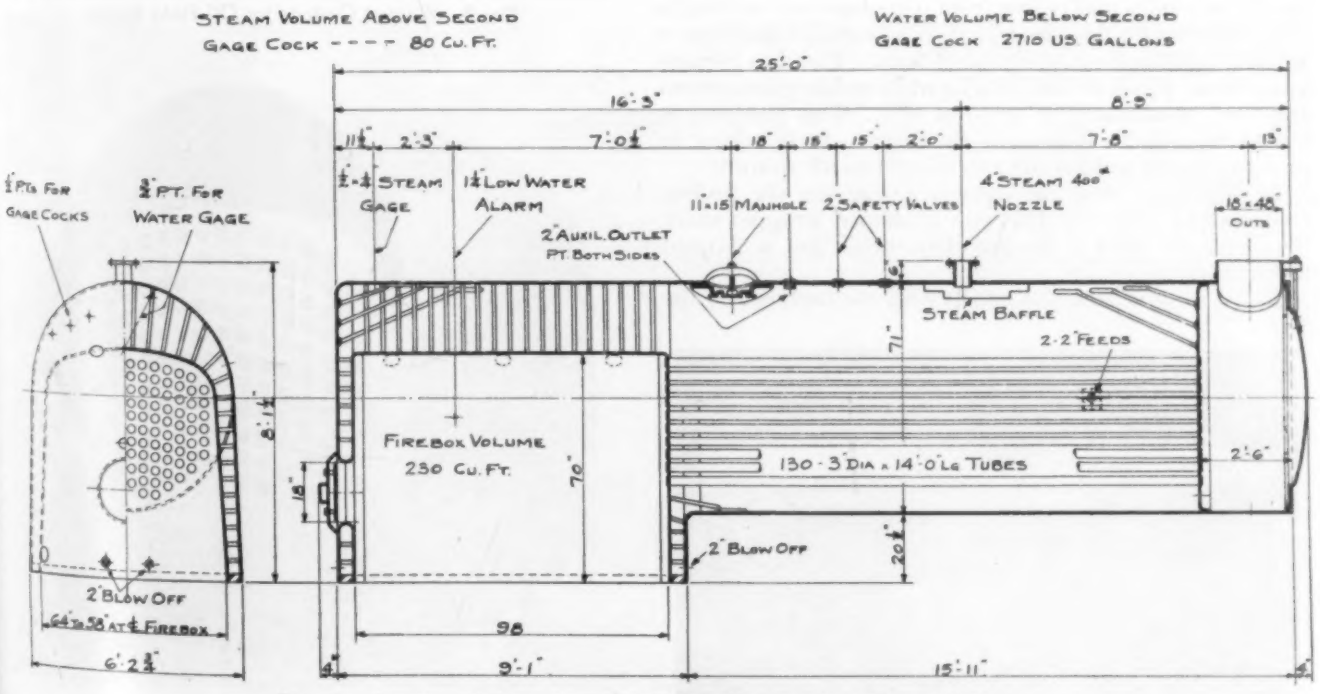

Fig. 1—Sectional Drawing of 150 HP Locomotive Type Boiler

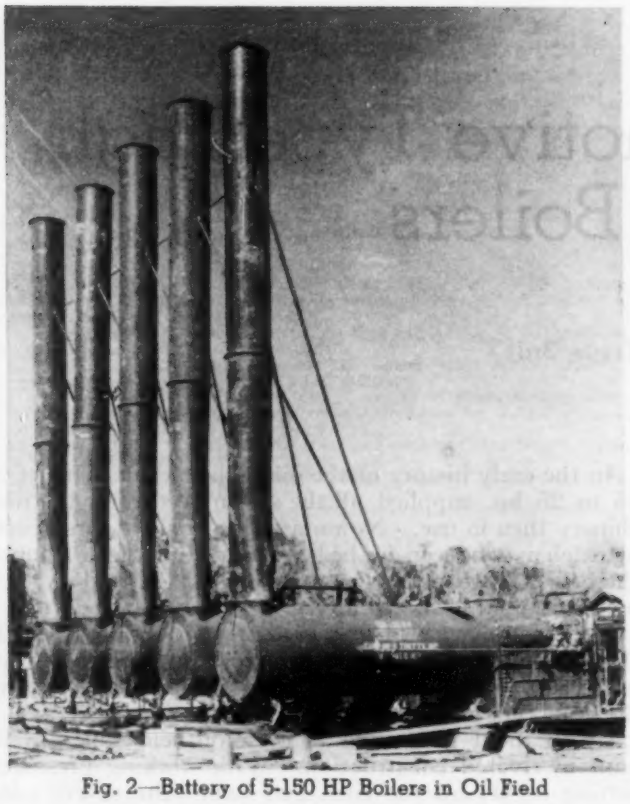

Fig. 2—Battery of 5-150 HP Boilers in Oil Field

details had to be worked out with Inspection Agencies and the ASME Boiler Code Committee but about two years later the all-welded oil field boiler came out and made a big show for itself.

Figure 4 is a 130-hp. all-welded boiler. This is just another example of welding filling a real need and being a definite advancement over riveting. The welded boiler brought along several other advantages, one of which was that with smooth insides the boilers were much easier to wash and keep clean. But as this paper is not a selling talk for welded boilers, I'll confine myself to the steps of construction.

First we make up the inside firebox, Fig. 5, by forming the firebox sides and crown from one plate and welding a door sheet and a flue sheet to it. A so-called mudring is welded together from heavy steel bars. This is a rectangular frame which we hold in a jig while welding the corners together, to make it of uniform size. This mudring is forced around the bottom of the firebox, tack welded in place and later welded solid to the plates all around.

At the same time the outside casing for the firebox comes along, Fig. 6. This is a U-shaped wrapper sheet to which we weld a flanged door head and a flanged throat sheet.

This casing is now assembled with the firebox and the

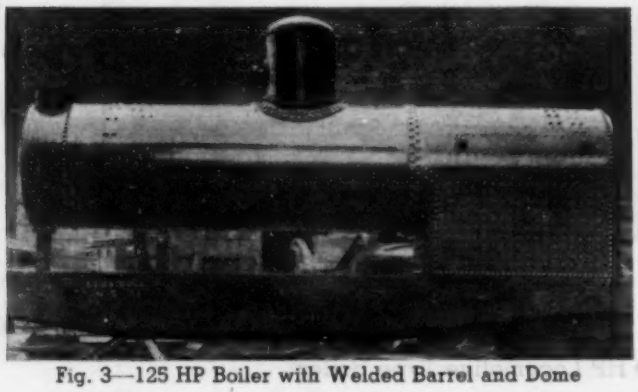

Fig. 3—125 HP Boiler with Welded Barrel and Dome

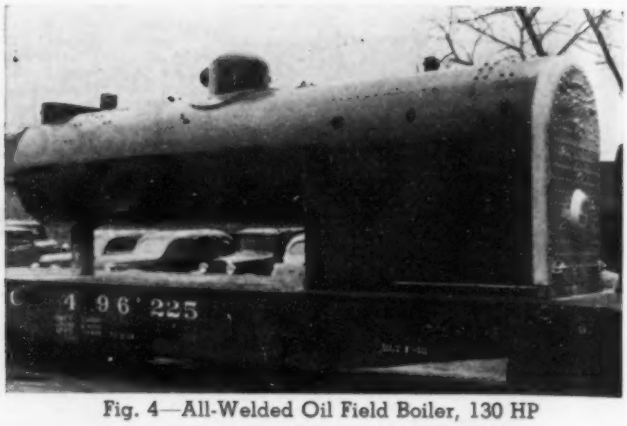

Fig. 4—All-Welded Oil Field Boiler, 130 HP

Fig. 5—Welded Fireboxes for Oil Field Boiler

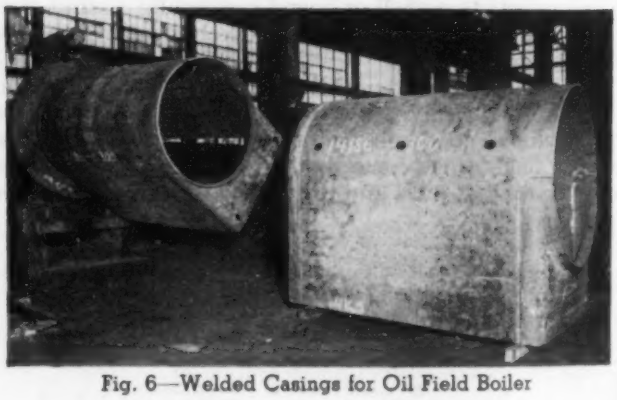

Fig. 6—Welded Casings for Oil Field Boiler

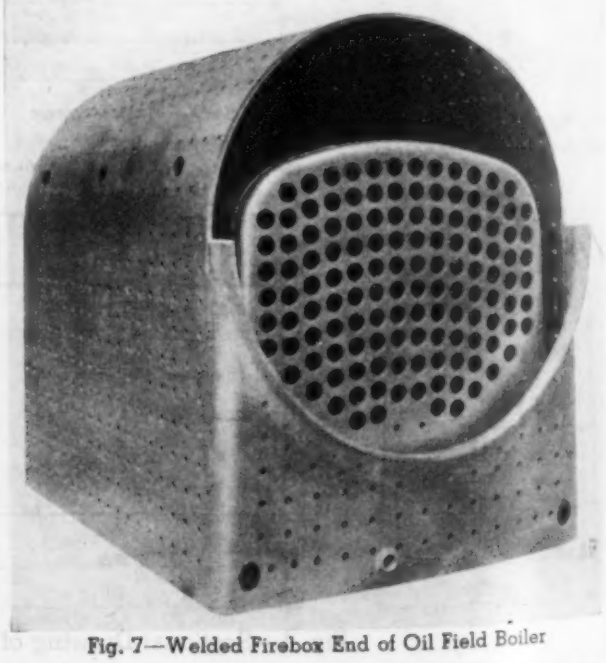

Fig. 7—Welded Firebox End of Oil Field Boiler

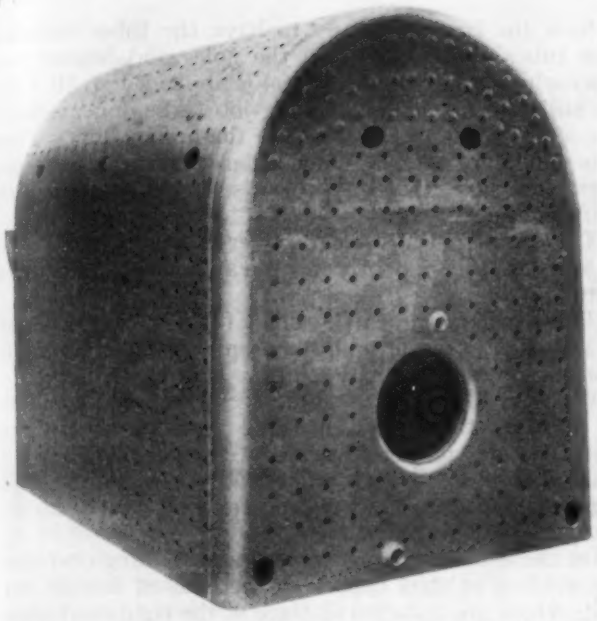

Fig. 8—Welded Fire Door End of Oil Field Boiler

welding of the mudring frame can now be completed all around the bottom. The bottom half of the throat sheet and the top of the outside wrapper form the circle to which the barrel is to be welded. In one size of boiler this circular end is in one level as shown in Fig. 6. In another size this end is offset as shown in Figs. 7 and 8.

Another welding operation is on the firedoor opening where the flanges of both openings come together and are butt welded. This section is supported with staybolts and the welding is so-called paragraph P-186 which does not require X-raying but must be done by qualified welders.

The next step is to install the staybolts to tie the sides and ends of this assembly together across the water space. These staybolts are to hold the flat plates against the internal pressure working in both directions. In flat or slightly curved surfaces this is necessary, otherwise the plates would bulge under the slightest pressure.

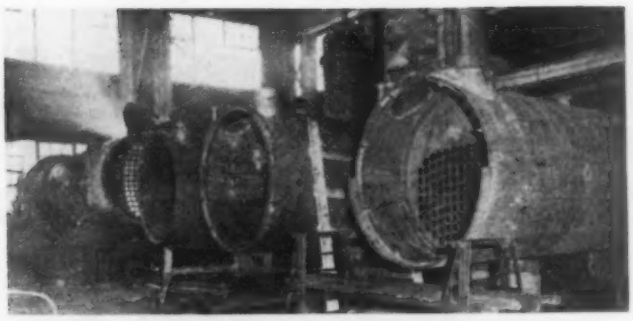

Fig. 10—Boilers on Line for Hydrostatic Test

Up to this summer the ASME Boiler code did not permit welded staybolts and all staybolt holes had to be reamed and tapped for a threaded staybolt. A boiler of this size has around 1200 staybolts spaced on about 4-in. centers and this operation takes a good amount of time.

One by one the staybolts are put in, and where necessary, trimmed off to extend slightly beyond the plates for heading over in a later operation. The ASME code is just now beginning to permit "welded-in" staybolts. A subcommittee of the Boiler Code Committee has been working on this problem for about two years and made extensive tests on the comparison in holding strength of welded stays as against threaded stays.

It may be said for welding that in every test the welded staybolt showed greater holding power than the screwed stay and this type of construction will be another marked advancement.

In another end of the plant the barrel end of the boiler is prepared. The barrel is made of two semicircular halves and the two longitudinal joints are welded in our Unionmelt machine.

A round fluesheet with tube holes to match the tube holes in the firebox fluesheet is welded in at one end. Diagonal braces for the unsupported part of the fluesheet above the tubes are installed, also a dry pipe for the steam

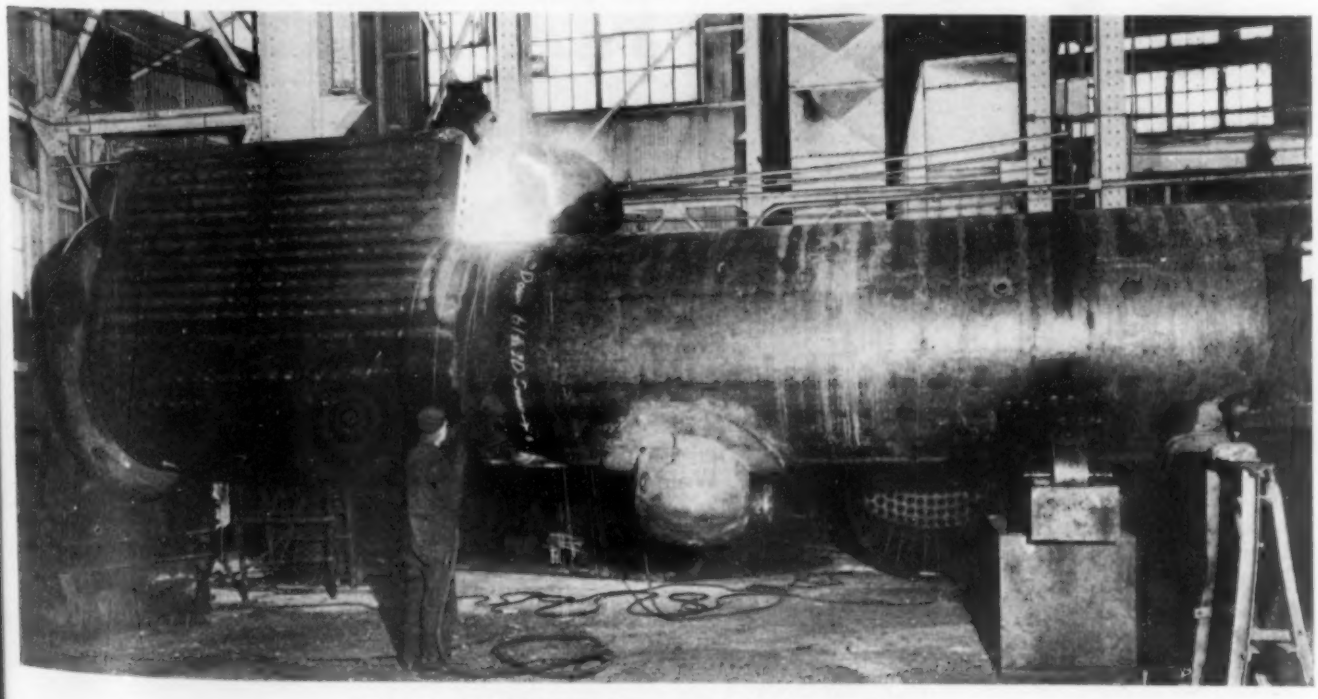

Fig. 9—Oil Field Boiler on Rotator for Welding

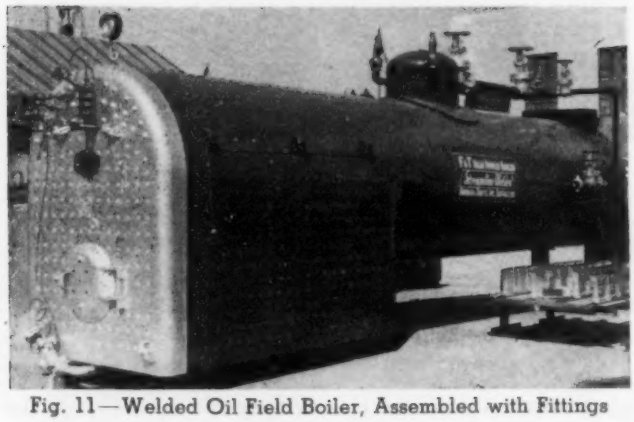

Fig. 11—Welded Oil Field Boiler, Assembled with Fittings

outlet and then the barrel end is ready for welding to the firebox end.

This welding is done on a rotator, Fig. 9. The firebox end is clamped to the rotator head and the barrel end supported on a set of rollers. The whole assembly can be rotated with the welder remaining in one position.

This rotator is a handy piece of equipment. It is also used for chipping the welds, touching up, installing the manhole frame, smokebox bonnet and to weld in the threaded and flanged fittings. For every operation the unit can be turned in the best position and the work done in the best and most economical manner.

During the various operations, the welds are X-rayed and now the welded unit is ready for stress relieving. We place it in our furnace for standard stress relieving treatment.

The operation of driving staybolts will of course not be necessary on welded staybolts which is another feather in the cap for welding. Besides getting a stronger and smoother construction the shop work can often be simplified.

Now the boiler is ready to have the tubes installed. The tubes are expanded in the holes and beaded over after which the hydrostatic test is applied, Fig. 10. But we still have one more welding job to be done, namely, the seal welding of the tubes on the firebox end. These tubes ends are always under a hard strain, and welding these ends after they are otherwise tight, gives them the extra holding power.

The assembled all-welded boiler is an attractive piece of work with its smooth and streamlined appearance as shown in Fig. 11.

These boilers are usually made for a working pressure of 350 psi., but we have built a number of them for 500 lb. working pressure.

We were told that a locomotive type boiler could not be built for this high a working pressure according to manual page such and such, but—we did not have the manual and went ahead. These 500-lb. boilers shown in Fig. 12 have been in operation for over two years and never had one bit of trouble.

On these boilers there is one more welding operation, the welding of steel caps over the ends of flexible staybolts which are installed in place of the rigid staybolts at points of greatest strain. These flexible staybolts are ball shaped on the outer end. This ball end fits in a cupped hole and permits sideways movement in all directions. To seal off this assembly against internal pressure of water or steam, a steel cap is welded over the ball end with a fillet weld all around.

The all-welded boiler has become a great favorite for oil field use and we ship them to all parts of the globe. Wherever they go, they are good messengers for the art of welding. Every one always looks twice at a welded boiler for its striking appearance and once put in use, an operator will never want to go back to a riveted boiler. On land or on water installations, they are the favorite everywhere.

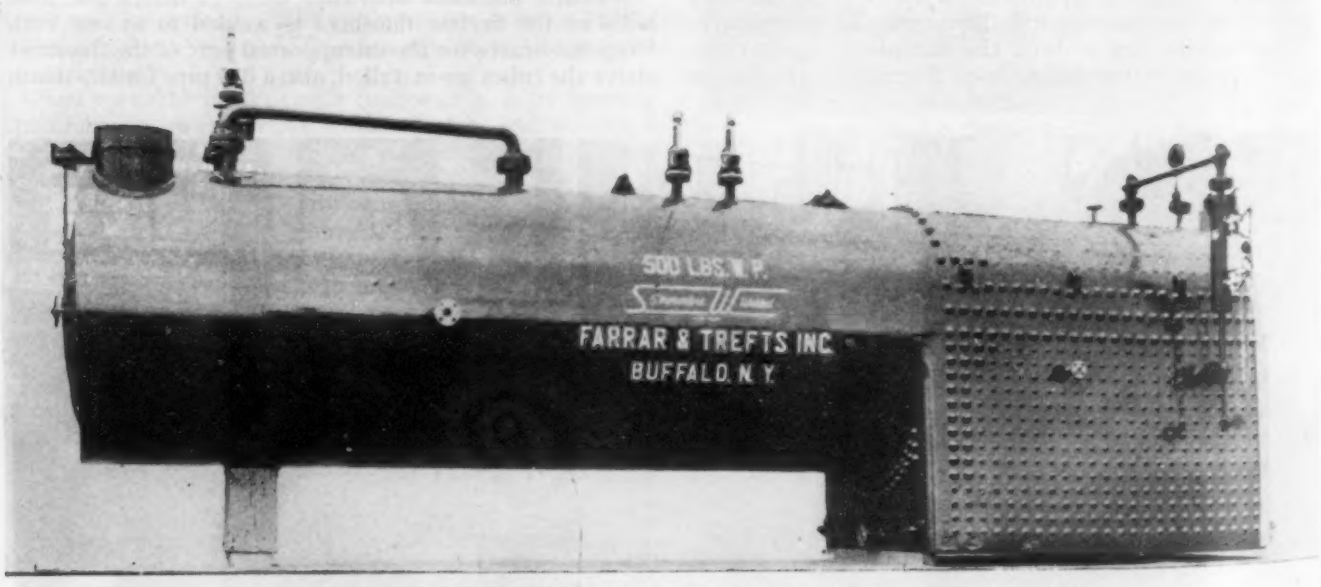

Fig. 12—150 HP-500 Psi. WP. Welded Oil Field Boiler with Superheater

New Developments in Railroad Maintenance-of-Way Work*

By C. A. Daley†

IN THIS paper I have tried to point out some of the more recent and important developments in the uses of the oxyacetylene torch in railroad maintenance-of-way work. Some of the operations are new and others are improvements in older uses of the torch to make a more efficient and economical operation.

Building Up Wheel Burns in Rail

A wheel or driver burn in a rail may look like a very insignificant surface damage to a rail, but in reality it may be a very serious damage and may be the cause of a progressive fracture.

Where the driving power of a locomotive is greater than the friction between the driver wheels and the rail, the driver wheels will slip and cause wheel burns. There are records of indicated peripheral speed of driver wheels of 112 mph. on a driver spin. If the engine is moving the burn is not likely to be as serious as in the case when the engine is just starting. In the latter case, the burn is localized and the extent of the damage depends on the length of spin.

The friction between the driver wheels and the rail in case of a spin generates enough heat to raise the temperature of the rail above the critical point of rail steel, the mass of cold metal in the rail acts as a quench agent, and the result is a hard martensitic structure in the rail at the point of slippage. This hard, brittle metal will eventually shell out, causing a depression in the rail and, in many cases, the burn may cause an incipient fracture which, if left undisturbed, will eventually grow under traffic and cause the rail to break.

Procedure for Welding Burns in Rail

All loose or laminated metal which cannot be removed with a cold chisel should be ground out or washed out with a welding or gouging tip, without heating the rail any more than necessary. If a grinder is used, the ground area should be washed clean with a torch before starting weld. During this washing-out operation, the operator should be on the lookout for any possible incipient fracture which is readily discernible, if present. In the event a fracture is found, the metal should be washed out to the bottom of the crack and then welded up. In the event the fracture is extensive, the rail should be replaced.

If the wheel burn is over 4 in., it should be built up in increments of about 3 in. in order to keep the heat input in the rail to a minimum. Since there are from four to eight burns in one slippage, depending on the size of the locomotive, the welder can move from one burn to another without losing any time waiting for the weld to cool. The weld can be surface finished with a flatter or grinder.

Oxyacetylene welding is recommended in this operation, in preference to arc welding.

Many railroads are now building up wheel burns and saving the replacement of a great many rails.

Flame Crowning or Straightening Joint Bars

Flame crowning or straightening worn and sagging joint bars in track is an effective and economical method of restoring joints to a better riding surface. When done in connection with rail end welding program, flame crowning the bars reduces the amount of welding and reforming required for a good joint surface.

Two torches are required in this operation, working simultaneously on opposite sides of the rail joint, using a large size welding or heating tip similar to Airco No. 12 welding tip or Airco Style 110 No. 1 round tip.

Heat is applied first in the center of the bar at the junction of the base and web of the bar with the cone of the flame directed downward and toward the base at all times. The flame is then worked up to the center of the web and down to the outer edge of the base. The pattern of the heated area should be more or less in the shape of a triangle, with the apex at the center of the bar.

The length of the base of the triangle to be heated depends on the amount of lift desired. This runs from 3 to 6 in.

In practice, the amount of dip in the joint is measured with a straight edge and the area to be heated is marked on the bears in advance of the torch men.

The principle of this operation is that the cold metal in the unheated portion of the joint bar acts as a C clamp on the heated portion of the bar, which results in a slight upset or shortening of the base.

Joints should be tamped to true surface as soon as bars have cooled.

Flame Hardening Open Hearth Steel Frogs

One of the outstanding recent developments in the application of the oxyacetylene process to railroad maintenance is the progressive hardening of the running surface of open hearth steel frogs.

Turnout and crossing frogs are parts of the track struc-

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* Presented at the Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

† Maintenance-of-Way Engineer, Technical Sales Div., Air Reduction Sales Co., New York.

ture which really get abuse due to the necessity of a flangeway in their construction.

It has been found that open hearth steel frogs and crossings, when flame hardened, will have a life equal to, or longer than, the more expensive manganese steel frogs and crossings.

All parts of the frogs or crossings which have been machined should be stress relieved before being flame hardened. The rails are flame hardened before the frog or crossing is assembled.

The wing rails or frog points to be hardened are submerged up to the ball of the rail in a tank containing a soluble oil solution. A special heating and quenching tip is required for this operation.

The tip, together with air dam and draw flame, is mounted on the arm of a radiagraph which is operated at a uniform speed. The sequence of the operation is to heat, quench and draw.

A soluble oil solution was found to be more satisfactory for a quench agent than water.

One advantage of flame-hardened frogs lies in the fact that a hard wear-resisting surface is produced without affecting the ductility of the remaining portion of the rail.

Flame Shortening Eyebars to Equalize Stresses

There are in existence many pin-connected truss bridges in use on railroads and on highways. Due to long usage, the pins and pinholes in the eyebars become worn to such an extent that the eyebars are loose and carry very little of the designed load. In many cases, the eyebars have become so loose that they will rattle for some time after a vehicle or train has passed over the bridge.

Various methods have been used in the past in an effort to tighten loose eyebars. The most common of these was a method involving the cutting of the member and welding or riveting plates or bars to it in such a manner that a turnbuckle could be applied for adjustment. The method is not only relatively expensive, but will develop in fatigue not more than 35% of the fatigue strength of the original section of the eyebar.

Another method which has been used to shorten eyebar tension members is to cut a short section out of the bar and then splicing it by welding on, or welding and riveting on, plates on both sides of the bar. The chief objection to this method is that very little dead load or initial stress can be placed in the bar and, here again, the detail will develop in fatigue not more than 50% of the fatigue strength of the original section of the eyebar.

The method which appears to be the most practical for tightening loose eyebars is to heat a small section of the bar to a cherry red and then upset this section by special clamps attached to the eyebar. This method for tightening eyebars has been used on American railroads for a number of years. A specially built charcoal furnace was used for heating the eyebar. It was not until recently that oxyacetylene torches were used instead of the charcoal furnace to heat the required area of the eyebar to be shortened. The use of torches has not only reduced the time required to hear the eyebar to the desired temperature, but also insures a more uniform temperature of the heated area. Eyebars shortened by this method, which is called flame shortening, appear to be unaffected in fatigue strength.

Reference to fatigue strengths mentioned above is taken from a recent report of Committee No. 15 on Iron and Steel Structures of the American Railway Engineering Association. That portion of the report on fatigue tests reads as follows: "The results of fatigue tests, included in the program of the Welding Research Council on the recommendation of the A.R.E.A., on eyebars that had not been shortened and eyebars that had been shortened. The results of these tests indicate that the flame shortening of the bars does not materially affect the fatigue strength of the bars: whereas comparable test on representative eyebar specimens shortened by other more costly methods showed that the fatigue strength of such specimens varied from 35 to 50% of the fatigue strength of the original eyebar. This research has therefore validated as safe practice, the most economical of the several methods, and it is estimated that if the method was used by the railroads in tightening all the loose eyebars, the resulting saving would be about one million dollars per year."

Butt Welding Rails

Butt welding of street car and railroad rails is not new but there have been recent improvements in this operation. In recent years there has been an increasing demand for continuous or butt-welded rail to eliminate joints in tunnels, street and road crossings and on bridges as well as in open track.

There are a number of different types of butt welds all of which have their place. These are Thermit, electric flash compression weld, closed and open type oxyacetylene compression weld and hand butt weld.

The Thermit weld is probably the oldest type weld used for butt welding rails. There are several improved types of this weld which are used quite extensively on railroads.

The more recent types of rail butt welds are the electric flash compression weld and the closed and open type oxyacetylene compression weld.

The closed pressure butt weld is made by butting the ends of the rail together and then heating the rails to a welding heat by an oxyacetylene flame applied to the top, bottom and web of the rail and at the same time applying pressure until there is a slight upset of the rail. The upset on the ball is then roughed off with a cutting torch and the weld stress relieved by the second application of heat and when the rail has cooled the weld is ground to surface on top and sides of the ball.

In this weld the ends of the rails is first prepared by grinding or sawing so that the rail ends are in the same plane—when butted together.

The open pressure butt weld is made by placing a special oxyacetylene heating tip between the ends of the rails to be welded and when the ends of the rails have reached the fusion point of the tips are retracted and the rails are quickly shoved together under heavy pressure. The slight upset resulting from this pressure is then removed and the weld stress relieved and when the rail is cool it is ground to surface on the top and side of the ball.

A great many butt welds are made by hand—where only a few welds are required such as circle and platform rails for turntable street and road crossing and station platforms.

There are some continuous welded rail sections a mile in length, but the majority of the sections are less because of signal and crossing bell installations.

The installation of sections in 300 to 600 ft. length is being given consideration for open track construction in place of the longer section because of the difficulty in handling the longer sections.

Flame Softening Corrugated Rails

Probably the most recent development for use of the

oxyacetylene torch in railroad maintenance is the tempering of hard spots in corrugated rails.

Corrugations often develop in rail to such an extent as to cause what is sometimes called "roaring track," due to the noise of passing trains. While the condition is not hazardous it does affect the riding quality of the track and increases maintenance costs and in general an objectional condition. Some railroads are equipped with grinder cars which are run over corrugated rail and the high spots of the corrugation is ground off. This is an effective and satisfactory way of removing corrugations but only a few roads are equipped with these cars and they are quite expensive to operate. All roads are equipped with torches and they are readily available.

Recent investigations show that the high spots which are bright and hard, have a martensitic structure with a Brinell hardness in some cases as much as 600. In treating corrugated rail with a torch, the hard spots are heated to a drawing temperature of 700 or 800° F. and allowed to cool. The rail will soon wear smooth after this treatment.

This process is still a live subject with the American Railway Engineering Association and further information on it should be available in the near future.

Flame Cropping Rails

In rail maintenance it is often desirable to crop rail when the fishing surface in the joint area becomes worn and the rail ends battered. Such rail is then fit for further service in either main line or secondary tracks. High speed friction or other type saws have been used for a number of years for rail cropping operations because there was no other method or means available. A number of roads have adopted the more recent method of cropping rail known as flame cropping.

In flame cropping rail two cutting torches are used, one superimposed on the other. One large rail cropping plant uses four radiagraph machines to actuate the torches. With this setup two cuts are made simultaneously—the forward end of one rail and the back end of the other.

For a small plant, a portable rail cropping machine which is operated by hand meets with favor. In flame cropping operations, a cut is first made across the ball of the rail and halfway through the web. The bottom torch cuts the base and up through the web to meet the first cut. The cropped end will then drop off. A flexible shaft hand grinder is then used to smooth up any irregularity which might be present at the junction of the two cuts and to grind a bevel on the top of the ball of the rail.

With a portable rail cropping machine two methods of operation may be used, either the rail is brought to the machine or the machine is brought to the rail. When the rails to be cropped are placed on skids the cropping machine is lifted by hand from one rail to the other. The machine has a three-point contact with the rail which automatically positions the machine for a square cut. Thirty-five cuts have been made in an hour with this machine but in regular production the number of cuts per hour are naturally somewhat less.

Flame Cleaning Bridges and Steel Structures

The usefulness of steel in any structure is limited by its tendency to rust or corrode. Millions of dollars are lost each year because of corrosion of steel structures. If these same steel structures could be kept in a dry atmosphere away from all moisture, salt air, brine drippings, acids and certain gases, there would be no need for painting or incasing the steel for protection against corrosion. Since this is out of the question, if steel structures are to be of any use, some sort of protection against corrosion is necessary under ordinary conditions. One of the biggest problems confronting engineers today is the prevention of corrosion.

The most common causes of corrosion, especially on steel structures on railways, are brine, locomotive exhaust gases and cinders, leachings from coal cars, dirty ballast accompanied by moisture, saltwater, fog and spray, dampness in unventilated places and ordinary water and atmosphere. With the foregoing in mind the necessity of excluding all moisture as well as removing all loose scale and rust is readily apparent before applying a protective coating. There are a number of ways and means of removing old paint and scale and rust from steel structures.

For removal of paint alone some source of heats generally used. For removal of scale and rust, hand chipping, hand and pneumatic wire brushing, sand blasting, and pneumatic chipping tools were heretofore used generally.

A more recent and more effective method of removing paint and scale and conditioning the surface of steel for painting is flame cleaning. Here the oxyacetylene torch equipped with special designed tips is used in conjunction with hand or pneumatic wire brushes and scrapers.

The oxyacetylene flame cleaning and dehydration is the process of rapidly removing loose semiadherent mill scale, and other surface impurities, as well as driving out any moisture from within and beneath the surface scale of structural steel and plate, by the procedure of quickly heating such deposits and the surface, with a hot multiflame oxyacetylene torch. The loose and semiadherent mill scales is caused to crack off as a result of the differential expansion between the scale and the base metal and at the same time any moisture present is converted into steam and driven off leaving the surface in a warm state.

Wire brushing should follow immediately and primer paint applied while the temperature of the steel is still above the temperature of the atmosphere but not hot enough to cause a separation of the oil in the primer coat.

Assurance against creepage of metal and distortion or warpage is had in that only a small local area is heated almost instantaneously to a temperature of approximately 300° F. Any scale that does not lift or pop off at this temperature is tenacious and unnecessary to remove.

For ordinary bridge or structural steel flame cleaning, 2- to 6-in. multiflame flat tips and a round miltiflame tip is recommended. For flame cleaning curved or round surfaces, such as pipes and steel poles, a multiflame flexible tube tip is recommended.

Tests not only show a saving in flame cleaning over any other methods of cleaning, but a better and longer lasting paint job is obtained.

A number of the above-mentioned operations have been the subject of study by committees of the American Railway Engineering Association and have been given their endorsement.

In conclusion, I would say that the oxyacetylene cutting and welding torches have been and will continue to be two of the most valuable tools in use in railroad maintenance-of-way work.

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1. BECAUSE—YOU Strengthen the Society: The Section is the "strength unit" of the Society. You are the "strength unit" of the Section. As an "active" Member, or a Member of a Committee or an Officer, you can make it possible for your Section to have live meetings, larger membership, outstanding speakers, more educational courses and activities of interest. Our Sections and Society need you to carry out an effective program, to aid in the development of technical and ethical standards for the welding industry. With your help the Section will never exhaust its possibilities; it will continuously extend its beneficial activities.

2. BECAUSE—of the Educational Benefits: You meet local, Sectional and National Speakers of proved merit; men of trained and broad experience in every phase of welding, cutting and allied process activity; men who are explorers in modern research and development. You receive the benefit of the combined knowledge of all members of the Society. You participate in educational courses, lectures and inspection trips.

3. BECAUSE—YOU Benefit Others: Without You the Section and Society would cease to exist. It asks You to take part in its discussions; to project Your ideas into its meetings; to register the value of Your experience; to excite the minds of others with Your problems; and to provide Your answers to the problems of your Fellow Member. Your beneficial returns are in direct proportion to Your cooperative and expended effort.

4. BECAUSE—YOU Benefit: You become acquainted with others in your community whose problems parallel yours. The prime objective is to aid you in all ways relating to the mutual activities and interest.

As an Executive—
—You are acquainted with broad economic developments affecting your company's operations; you are made aware of ways and means for reducing your welding, cutting and allied process operating costs—thus broadening your profits.

As a Salesman—
—You are provided an opportunity to meet your present and prospective customers, to consult with engineers regarding their specific requirements and broader adaptation of your product to their needs.

As an Engineer—
—You are kept abreast of the most recent developments in welding metallurgy, methods, procedures and techniques affecting design, construction and production volume.

As a Supervisor or Operator—
—You are made aware of the better shop practices, the best materials, the proper codes, standards and specifications, types and styles of welding and safety rules.

And naturally, there are many other good reasons why you certainly will want to support Your Section. Good fellowship, social activities, community spirit, and the desire to contribute your bit for the good of all, being but a few.

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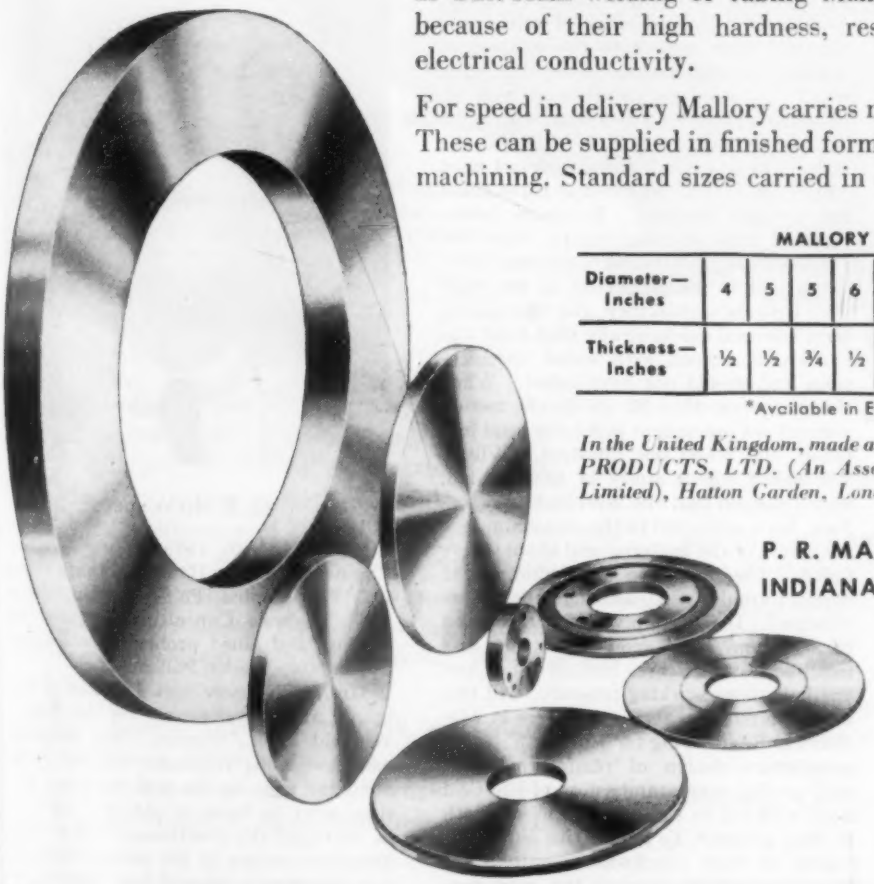

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Thickness—Inches	½	½	¾	½	¾	⅜	⅜	½	¾	⅜	½	¾	½	1

*Available in Elkaloy "A" (R.W.M.A. Class 1).

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DR. A. B. KINZEL RECEIVES MILLER MEDAL

Dr. A. B. Kinzel, Vice-President, Electro Metallurgical Co., and Union Carbide and Carbon Research Laboratories, Inc., New York, received the Samuel Wylie Miller Memorial Medal at the 1947 Annual Meeting of the SOCIETY at the Hotel Sherman, Chicago, on Monday, October 20. The medal is awarded annually by the SOCIETY for conspicuous contributions to the advancement of the welding or cutting of metals.

Dr. Kinzel graduated from Columbia University, A.B., in 1919, Massachusetts Institute of Technology in General Engineering, 1931, and the University of Nancy, France, D.Met.Ing., 1922, where he received the degree of Doctor of Science in 1933. Before joining the Union Carbide organization in 1926, he had several years' experience as metallurgist with General Electric Co. and Henry Disston & Sons, as lecturer of the advanced courses in metallurgy at Temple University, and as a consultant.

Dr. A. B. Kinzel

Dr. Kinzel is the author of many papers on the testing and welding of metals, on the metallurgy and physical chemistry of steelmaking, on the composition, physical properties and uses of ferroalloys and alloy steels, and on applied mechanics, and is co-author of the volumes on chromium in the "Alloys of Iron" series of monographs. He holds many patents in these fields.

Dr. Kinzel has headed many important committees of the AMERICAN WELDING SOCIETY, American Institute of Mining and Metallurgical Engineers, American Society for Metals, and other technical societies, and is now Director of the AMERICAN WELDING SOCIETY, Director of the American Institute of Mining and Metallurgical Engineers, and Chairman of the Engineering Foundation Board as well as Chief Consultant in metallurgy to the Los Alamos Laboratories and the Argonne National Laboratories of the Atomic Energy Commission. During the war, in addition to his work for the Manhattan District, Dr. Kinzel was Senior Consultant on metals to the War Production Board, Chief Consultant on metals to the Enemy Branch of the Foreign Economic Administration, Project Supervisor of the War Metallurgy Committee, and served T.I.I.C. in England, France and Germany as head of the Metals Section (Assimilated Brigadier General).

Dr. Kinzel has lectured widely, including special lectures such as guest lecturer of the Society of Culture of the U.S.S.R. in Moscow in 1936, Adams Lecturer of the AMERICAN WELDING SOCIETY in 1944, and is Campbell Lecturer of the American Society for Metals for 1947.

Response by Dr. Kinzel

It is with a peculiar personal satisfaction that I accept the distinction conferred by the Samuel Wylie Miller Medal. This satisfaction comes not only from an appreciation of its significance, but also from my former close association with Samuel Wylie Miller. He was in general charge of welding at the Union Carbide and Carbon Research Laboratores, Inc., and I had the very good fortune of working directly for him on several problems. From that association I learned much of value, particularly with respect to the relation of science to engineering, and the basic truth that scientific theory may well explain an engineering fact but will never explain it away. A case in point was the rupture of a welded pressure vessel head which had failed under test at three times the working pressure. Extensive investigation proved conclusively that the properties of the steel were entirely satisfactory, that the properties of the weld were entirely satisfactory, and that metallurgically and mechanically that head was entirely in accord with sound specifications and should not have failed. When this was reported to Mr. Miller, he merely pointed out one salient fact—the head had failed, and posed one question, "Why?" The result was a study of head design, which showed that the head had, in ignorance, been subjected to the maximum tensile stress of the material and should have failed. The ignorance was found in the design formulas used, although these were standard. It was simply that with welded construction, heads could, for the first time, be tested at three instead of one and one-half times working pressure. All this was reported in a series of papers in Mechanical Engineering for June 1927, and a satisfactory design of reinforcement as well as the now standard semi-elliptical head with a 2 to 1 axis ratio was set forth in these papers. To pursue this particular failure to that conclusion required not only the scientific approach but, more particularly, the super-position of the factual engineering mind. This rare combination characterized Samuel Wylie Miller, and I have been trying to emulate him ever since. The application of the scientific method to the art of engineering was Samuel Wylie Miller's forte. Happily, it leads to results of value to mankind. I accept this Award with a keen appreciation of Samuel Wylie Miller's philosophy and teachings.

G. S. MIKHALAPOV CHOSEN ADAMS LECTURER BY AMERICAN WELDING SOCIETY

G. S. Mikhalapov, Manager, Apparatus Research Dept., Air Reduction Sales, New York, gave the Adams Lecture at the 1947 Annual Meeting of the AMERICAN WELDING SOCIETY at the Hotel Sherman, Chicago, on Monday, October 20th. The lectureship is awarded annually to an outstanding Scientist or Engineer. It was established in honor of the first President and founder of the AMERICAN WELDING SOCIETY.

Mr. Mikhalapov graduated in 1926 from the Massachusetts Institute of Technology with a degree of B.S. in Electrical Engineering. After seven years with the Stone and Webster Engineering Corp., Boston, Mass., he became interested in welding and spent over a year studying welding practices, methods and applications throughout industry.

G. S. Mikhalapov

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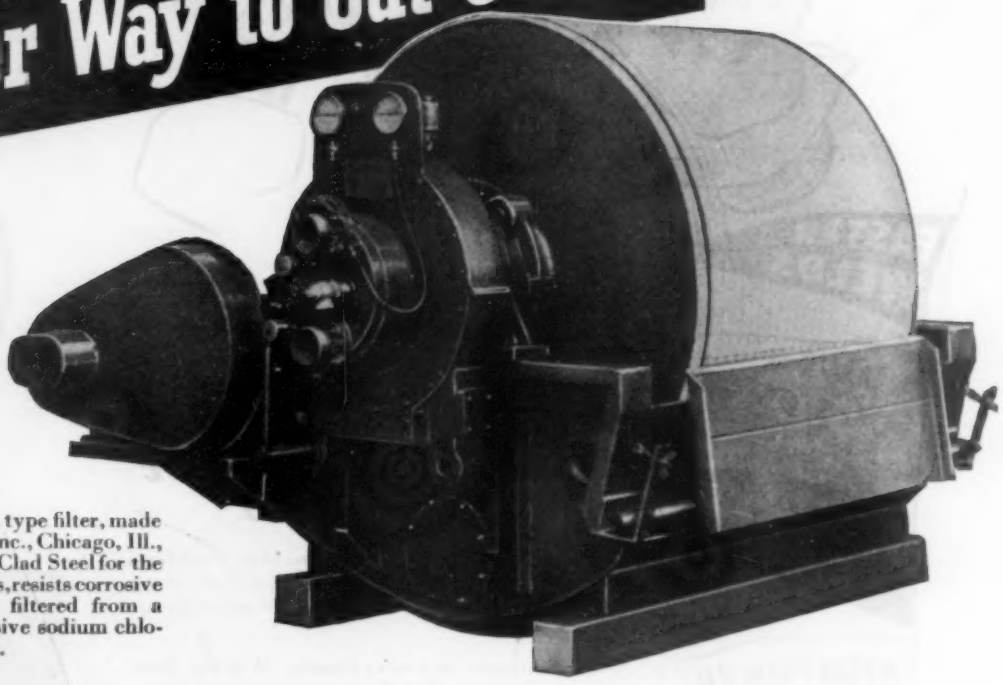

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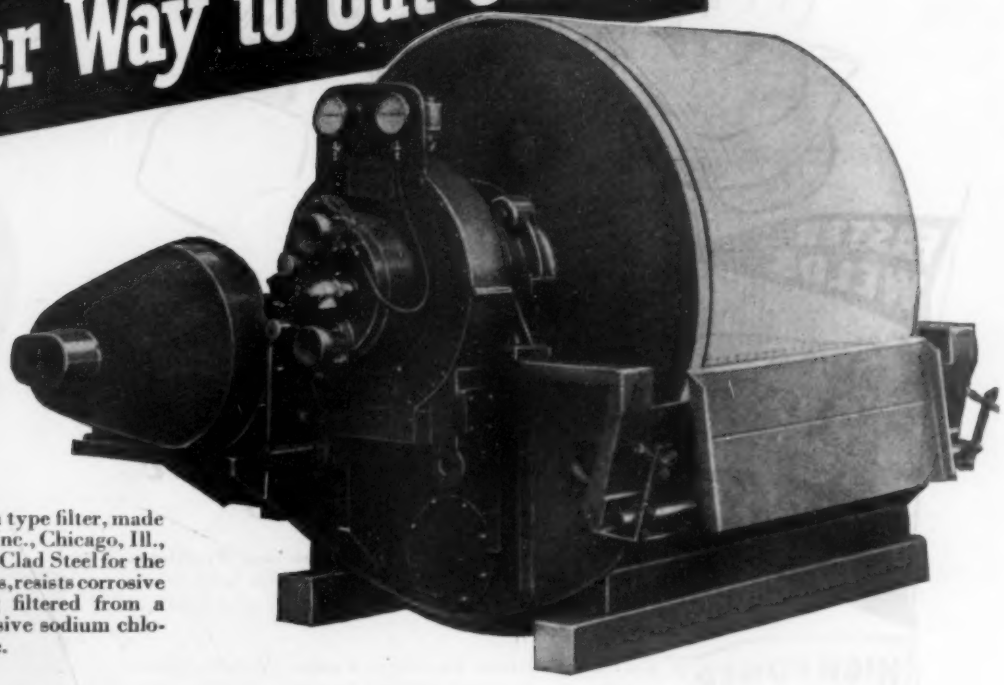

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Until 1946 Mr. Mikhalapov had direct supervision of some 31 welding research projects conducted in industrial and educational Laboratories throughout the country. During this period he served as a member of the Sub-Board appointed by the Secretary of the Navy to Investigate the Design and Methods of Construction of Welded Steel Merchant Vessels and assisted the Board as Chairman of Research Advisory Committee to the Board.

LINCOLN WELDING AWARD

The AMERICAN WELDING SOCIETY announces the selection of the paper entitled "Arc Atmospheres and Underbead Cracking" by Perry J. Rieppel and Manley W. Mallet of Battelle Institute for the Lincoln Gold Medal Award.

Sponsored by James F. Lincoln, President, Lincoln Electric Co., the award is

P. J. Rieppel

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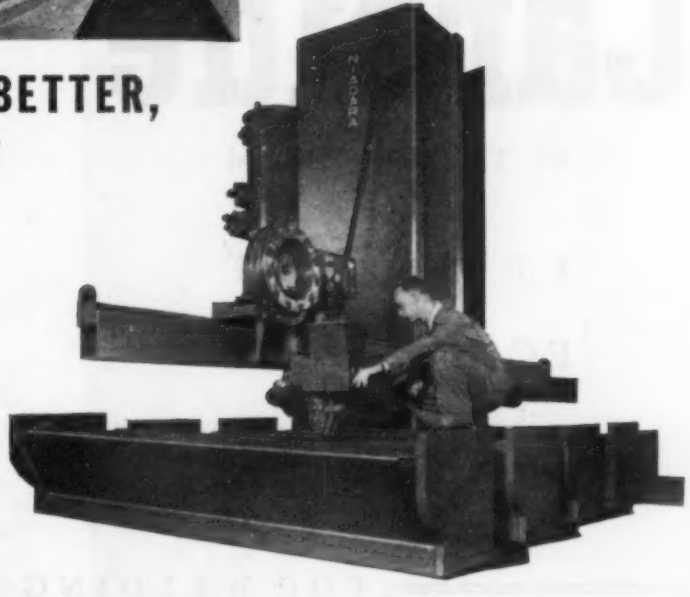

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made annually by the SOCIETY for the paper representing the greatest contribution to the advancement and use of welding. As the major contributor to the paper, Mr. Rieppel was awarded the medal, and a certificate was given to both scientists.

Perry J. Rieppel is a member of the Welding Research Staff of Battelle Institute. He holds a Bachelor of Science degree from the Mansfield State Teachers College and also attended Cornell University and the University of Buffalo. Before joining the Battelle Staff in 1943, he served as a Welding Technician for the Curtiss-Wright Corp. He is a member of the AMERICAN WELDING SOCIETY, American Society for Metals and Sigma Xi, honorary scientific society.

Manley W. Mallet has been associated with Battelle since 1942 as a research engineer in industrial physics. He is a graduate of Toledo University and also studied at the University of Pittsburgh. His past experience includes technical positions with the National Bureau of Standards, the Crucible Steel Co. of America and the Owens-Illinois Glass Co. He is a member of the American Society for Metals and Sigma Xi, honorary scientific society.

TWO SCIENTISTS WIN AWARD OF AMERICAN WELDING SOCIETY

The AMERICAN WELDING SOCIETY announces the award of the $200 second prize in the Resistance Welder Manufacturers Association Prize Contest to Robert C. McMaster, Research Physicist, Battelle Institute, Columbus, Ohio, and F. C. Lindvall, Professor of Electrical and Mechanical Engineering, California Institute of Technology, Pasadena, Calif.

R. C. McMaster

F. C. Lindvall

Mr. McMaster and Prof. Lindvall are co-authors of the paper entitled "The Interpretation of Radiographs of Spot Welds in Alclad 24 S-T and 75 S-T Aluminum Alloys" which has been selected as the second best paper in the contest from a University source.

Mr. McMaster is a graduate of Carnegie Institute of Technology and California Institute of Technology, where he received the Ph.D. degree in the field of Electrical Engineering and Physics. Prior to the war, he worked with the General Electric Co. and the Naval Ordnance Laboratory and taught Electrical Engineering at the Case School of Applied Science and at California Institute.

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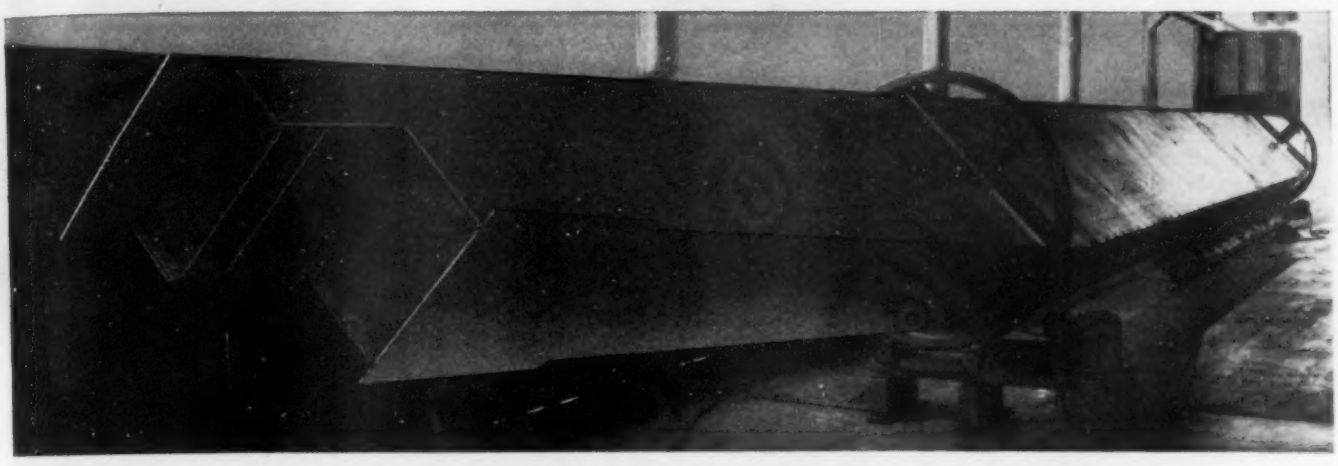

Fig. 1. The 100′ crane box section is mounted in rotating fixture which positions all finish welding for downhand.

By BOYNTON NISSEN,
Partner in Charge of Operations
Milwaukee Crane & Service Co., Milwaukee, Wis.

FIG. 1 shows a large crane box section, fabrication cost of which was recently reduced by adopting "Fleetwelding" techniques that greatly speed up the welding.

This box section is made from mild steel plate and is approximately 100′ long. The sides are 60″ wide and ⅜″ thick; bottom is 24″ wide and ½″ thick; top is 24″ wide and ⅝″ thick.

In Fig. 1 note the motor-driven positioning fixtures which are used to rotate the weldment, so as to put all welding in the downhand position. This is the first principle of "Fleetwelding".

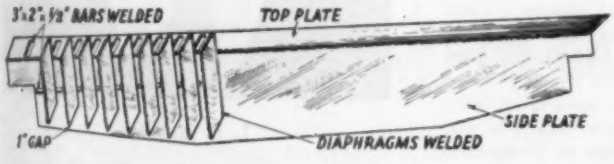

Fig. 2. Schematic view of the box section.

The ring fixtures are discarded locomotive tires which we salvaged from a scrap heap.

Fig. 2 is a sketch of the box section, showing internal diaphragms. The first step in assembly is to lay one of the side plates on a long work table and weld the diaphragms to it at approximately 3½′ intervals. Second, the top cover plate is skip-welded to the diaphragms and side plate. Bars 3′ x 2″ x ½″ are welded to sides and top to prevent buckling. Third, with assembly still on the work table, the other side plate is welded to the top plate and diaphragm. Fourth, the assembly is picked up with a hoist, turned and set on horses, and the bottom plate tacked on. There is a gap of about 1″ left between the diaphragm and the bottom plate so that any water that might accumulate inside the box section can run out of holes that are punched in the bottom plate, preventing rusting.

The last operation is insertion of the section in the rotating fixture for finish welding of all outside seams. In accordance with "Fleetwelding" principles, the electrode size for best speed and highest practical current is used. The good fit-up of the members further increases welding speed. Fig. 3 shows how the operator makes continuous welds joining web to flange, with assembly in the 45° "flat-fillet" position. ¼″ "Fleetweld 9″ electrode at 300-325 amps. is used. A total of 250′ of welding is required to join the webs to upper and lower flanges.

The adoption of these procedures has increased the welding speed from approximately 6″ per minute to 12″ per minute, and thereby decreased the total welding time from 11 to 7 hours.

Fig. 3. Making speedy "flat fillet" finish welds with "Fleetweld 9".

The above is published by LINCOLN ELECTRIC in the interests of progress.
For Machine Design Studies, write The Lincoln Electric Company, Dept. 1211, Cleveland 1, Ohio.

During the war period, he supervised Aircraft Welding and X-ray research projects at California Institute and conducted research nondestructive testing of spot welds, flash welds and aircraft parts and castings; in the spot welding of heavier gages of aluminum alloys; and in radiography and fluoroscopy.

He is a member of the AMERICAN WELDING SOCIETY, the American Institute of Electrical Engineers, the Industrial Radium and X-ray Society and several engineering honor fraternities.

Professor Lindvall was born May 29, 1903, at Moline, Ill. He attended the University of California at Los Angeles for two years and graduated from the University of Illinois in 1924 with the degree of B.S. in Railway Engineering.

Following a year in the office of the Electrical Engineer, Los Angeles Railway Corp., he taught fellow and graduate students at California Institute of Technology receiving degree of Ph.D. in Electrical Engineering and Physics in 1928. Since 1930 Prof. Lindvall has had various academic appointments at California Institute of Technology. He is currently Professor of Electrical and Mechanical Engineering, Chairman of the Division of Civil and Mechanical Engineering and Aeronautics, and a Member of California Institute of Technology Executive Committee. He is also a Consultant and Director of Preco, Inc., Los Angeles, and a Director of Consolidated Engineering Co., Pasadena.

JULIUS HEUSCHKEL WINS $750 PRIZE FOR WELDING PAPER

The AMERICAN WELDING SOCIETY announces the selection of Julius Heuschkel's paper entitled, "Some Metallurgical Aspects of Carbon Steel Spot Welding" as the winner of the $750 first prize in the Resistance Welder Manufacturers' Association prize contest. The award was made Monday, Oct. 20th, during the Annual Meeting of the SOCIETY at the Hotel Sherman, Chicago.

Mr. Heuschkel is in active charge of Welding Research at the Westinghouse Research Laboratories. He has been engaged in this type of work since 1930, first with the U. S. Navy Department,

Julius Heuschkel

later with the Carnegie-Illinois Steel Corp., and since 1944 with the Westinghouse Electric Corp. He is the author and co-author of several contributions to the AMERICAN WELDING SOCIETY and was also the winner of the 1946 R.W.M.A. award. Mr. Heuschkel is a Civil Engineering graduate of Montana State College.

BATTELLE PHYSICISTS WIN WELDING SOCIETY AWARD

Horace J. Grover and Lloyd R. Jackson, Physicists, Battelle Institute, Columbus, Ohio, are co-authors of the third best paper from an Industrial source in the Resistance Welder Manufacturers' Association prize contest of the AMERICAN WELDING SOCIETY. They received $250 and certificates on Monday, Oct. 20th, at the 1947 Annual Meeting of the SOCIETY at the Hotel Sherman, Chicago. Their paper is entitled "Fatigue Tests on Some Spot-Welded Joints in Aluminum-Alloy Sheet Material."

Mr. Grover has been associated with Battelle since 1942, prior to which he was a member of the Faculty at Rensselaer Polytechnic Institute. He holds Bachelor of Arts and Master of Arts degrees from the University of Rochester and a Doctor

Horace J. Grover

L. R. Jackson

of Philosophy degree from Cornell University. He is a member of the American Physical Society and several honorary

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scholastic and scientific Societies, including Phi Beta Kappa, Sigma Xi and Phi Kappa Phi.

Mr. Jackson, the senior member of the pair, has been a member of the Battelle staff since 1935. He received a Bachelor of Science degree in Electrical Engineering from the University of Colorado and a Master of Science degree in physics from Yale University. Prior to joining the Battelle staff, he was an assistant Research Supervisor for the Jones and Laughlin Steel Corp. He serves on the Joint Subcommittee on Capillary Brazing Materials of the AMERICAN WELDING SOCIETY and American Society for Testing Materials; Committee E9 on Fatigue, of the American Society for Testing Materials; and is also affiliated with the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the American Physical Society and Sigma Xi.

D. BRUCE JOHNSTON WINS WELDING AWARD

The AMERICAN WELDING SOCIETY announces the award of the $500 prize in the 1947 Resistance Welder Manufacturers Association contest to D. Bruce Johnston, a partner in the firm of McPhee and Johnston, New York. This prize was awarded Mr. Johnston on Oct. 20th at the 1947 Annual Meeting of the SOCIETY at the Hotel Sherman, Chicago, for submitting the second best paper from an industrial source in the contest.

D. Bruce Johnston

Mr. Johnston is an engineering graduate of the University of London, England. He worked in various civil engineering capacities in England from 1929 to 1933 and obtained the Robert Blair Fellowship in the amount of $2300 awarded by the London County Council in 1933 for the study of electric welding, especially in its application to structural steelwork in the U.S.A. In 1933, Mr. Johnston became an engineer with Lukenweld, Inc., division of Lukens Steel Co., Coatesville, Pa., working in various capacities until 1943 when he was appointed Assistant to Director of Research for Lukens Steel Co. and subsidiaries. In 1945 he entered into partnership with an associate, Mr. Alexander H. McPhee, to form the firm of McPhee and Johnston, 90 West St., New York 6, N. Y., as Engineers, Designers and Builders of Special Machinery.

He is the author of several technical papers, a member of the Institution of Civil Engineers, London, the American Society of Mechanical Engineers and holds a Professional Engineering license in Pennsylvania.

FOUR SCIENTISTS WIN WELDING AWARD

The AMERICAN WELDING SOCIETY announces the award of the $300 first prize for the best paper from a university source in the 1947 Resistance Welder Manufacturers Association contest to Dr. Wendell F. Hess, Dr. T. B. Cameron, Dr. F. J. Winsor and Dutton J. Ashcraft, all present or former members of the staff of the Rensselaer Polytechnic Institute, Troy, N. Y. The awards were presented at the 1947 Annual Meeting of the SOCIETY at the Hotel Sherman, Chicago, on Oct. 20th.

Wendell F. Hess

Thomas B. Cameron

Dr. Hess is head of the Department of Metallurgical Engineering at R.P.I. He is a Past-President of the AMERICAN WELDING SOCIETY and the recipient of several honors and awards from the A.W. S. and other scientific organizations.

Dr. Cameron is an Assistant Professor of Chemistry at the University of Cincinnati. A graduate of R.P.I., Dr.

F. J. Winsor

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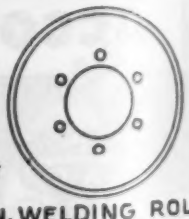

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Cameron was a faculty member there from 1939 until he accepted his present appointment in 1946. During the war he was a research fellow and a consultant on national defense research projects at R.P.I. He is a member of the American Chemical Society and Sigma Xi, and the author of several published technical papers.

Dr. Winsor is a Research Metallurgist with the Armour Research Foundation, Chicago. He graduated from R.P.I. in 1942 and from 1942 to 1946 he was a research assistant in the welding laboratory at that college. Dr. Winsor is also a member of the Sigma Xi and the American Society for Metals.

D. J. Ashcraft

Mr. Ashcraft is a Junior Engineer, Technical Service Division, Standard Oil Company of Ohio, Cleveland, Ohio. He received his B.S. in Chemical Engineering in 1943 and an M.S. in Metallurgy in 1945, both from R.P.I. Mr. Ashcraft was a research assistant there from 1944 to 1945 working on national defense research projects.

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L. M. DALCHER JOINS FAIRBANKS, MORSE & CO.

James W. Owens, Technical Assistant to the General Manager of the Beloit Works of Fairbanks, Morse & Co., has announced the addition to his staff of L. M. Dalcher, formerly Technical Secretary of the AMERICAN WELDING SOCIETY.

Leslie M. Dalcher

Mr. Dalcher obtained his technical education at the Polytechnic Institute of Brooklyn, where he pursued both undergraduate and graduate studies in physical metallurgy. From 1934 to 1936 he was employed in the research laboratories of the International Nickel Co., and in the latter year resigned to accept the position of metallurgist for the Crucible Steel Co. of America, which position he held until he joined the AMERICAN WELDING SOCIETY as Assistant Technical Secretary in 1939. Three years later he was advanced to the position of Technical Secretary. Mr. Dalcher is the author of several articles on welding which have appeared in THE WELDING JOURNAL and other technical

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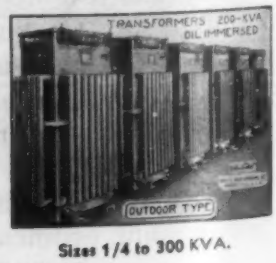

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publications. He has also delivered a number of talks before local and national meetings of the A.W.S.

In assuming his new position with Fairbanks, Morse & Co., Mr. Dalcher will be the Standards Engineer in the company's newly organized Standards Department.

PHONOGRAPH TURNTABLES

With a couple of drawing and stamping presses, some spraying equipment and two press-type, battery-operated resistance welders, a new company—Precision Manufacturing Co. of Bergholz, Ohio—has just about succeeded in cornering all the production of phonograph turntables.

With some 15 major phonograph producers as its customers, this division of Alliance Manufacturing Co., Alliance, Ohio, with some 75 workers from near-by Bergholz turns out many thousand turntables a day, running two shifts to keep up with orders.

Considering the fact that the plant was built five miles from the nearest power substation, this output—requiring high production welding—would have been impossible before the war. All the electric line load Precision was allowed is 15 kva. Heavier loads would cause serious flicker and voltage drops in the neighboring community. However, that did not stop Precision's owners. They are using welders powered with storage batteries developed by Progressive Welder Co., Detroit. All the current Precision needs to keep these welders operating 16 hours a day is a maximum of 30 amp. on a 220-v. line to operate a standard 3-phase package type battery charger.

No two of the various types of turntables produced by Precision are identical, yet H. H. Long, General Manager of the Company, has been able to use pretty much the same production process on all types. Prime reason for this is that the major differences between turntables is in the mounting bracket. Figure 1 shows a standard turntable with four different types of mounting brackets. Note that each bracket is provided with a series of small projections. The brackets are welded to the turntables in a single welding operation.

The drawn and punched turntable is placed over the bracket in the lower die, the head of the machine is brought down and battery current is turned on automatically through a contactor controller to form the six welds at the projections simultaneously.

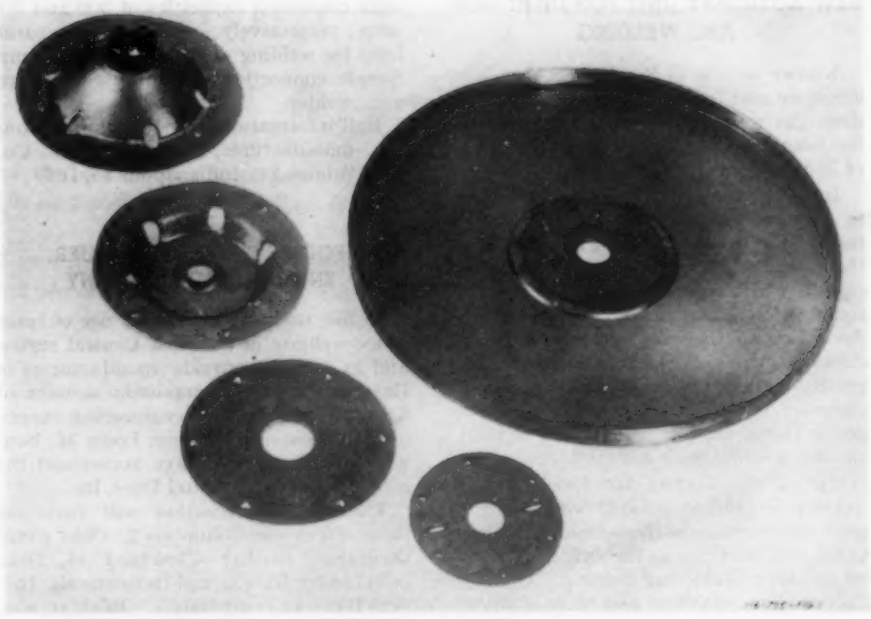

Fig. 1—Typical Assembled Turntable, with Four of the Various Types of Mounting Brackets Which Are Projection Welded to the Underside on Progressive Battery-Operated Projection Welders, for Different Phonograph Manufacturers

The machines are standard Progressive press-type projection welders equipped with water-cooled storage batteries and carbon-disk type contactor. A simple weld sequence timer causes the machine to press the parts together for one second, hold the welding current on for $^1/_3$ second and hold the parts under pressure during cooling for $^1/_2$ second. At the end of the cycle, the head of the machine lifts for removal of the completed assembly—a matter of less than two seconds.

Material used is 18-gage steel throughout. Rejects are said to be negligible. Periodic inspection of weld quality is made (twice a day) by attempting to pry the brackets loose from the turntable with a chisel.

It should be pointed out, too, that the use of battery welders also made unnecessary the installation of heavy conductors to carry the high welding current. Feeders to the battery chargers at the machines are only No. 12 wire.

METAL GAGE COMPARATOR CHART

Published by Twin "K" Products, 2322-F Newport Ave., Dayton 5, Ohio, this chart gives the equivalents of metal gages in thousandths, fractions, millimeters, mils and circular mils. The gages so interpreted are Sheet Lead, Sheet Zinc, Sheet Copper, Birmingham (Stubs), American (B. & S.), U. S. Standard (old), U. S. Standard (new), U. S. Steel Wire (formerly W. & M.), Piano Wire (Am. S. & W. Co.), British Standard (Imperial) and Stubs' Steel Wire. Measurements are shown up to $^1/_4$ in. in increments of 0.001 in. An index tells which gages are applicable to the various classes of sheets, wires, rods and tubes. One of the purposes of the chart is to avoid misunderstandings by specifying thickness or diameter in additon to gage numbers. The chart is 23 x $10^1/_2$ in. in size, printed on heavy cover stock. It is offered in quantities, with imprint, to manufacturers who wish to present it to customers as a good-will item. Individuals can obtain copies direct from the publisher.

WELDING CONNECTORS
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NEW AUXILIARY UNIT FOR INERT GAS ARC WELDING

Known as the G-R "Correct-Arc," an auxiliary unit for use with a.-c. welders on inert gas welding with "Heliarc" torches has been announced by Glenn-Roberts Co. of Indianapolis.

In addition to a high-frequency circuit to start and maintain the arc without contacting the work piece with the electrode, the Correct-Arc has a unique filter-choke circuit which substantially reduces the rectification effect of the inert gas arc. According to the manufacturer, this exclusive Correct-Arc feature removes or greatly reduces the causes of overheating, excessive input, reduced output and low power factor usually encountered in inert gas arc welding with a.-c. welders.

Use of the Correct-Arc for inert gas welding is said to provide virtually the same output range at the same input, power factor and heat rise as the welder exhibits on regular metallic arc welding. Greatly improved arc stability and more uniform heat input to the weld are also reported, particularly on aluminum and magnesium welds.

The Correct-Arc is available in two sizes with maximum capacities of 300 and 600 amp., respectively; units may be paralleled for welding at higher than 600 amp. Simple connections permit use with any a.-c. welder.

Full information may be obtained from the manufacturer, Glenn-Roberts Co., 2107 Adams St., Indianapolis 18, Ind.

FORM BENKERT AND DUER ENGINEERING COMPANY

In line with the expanding use of resistance welding in the East Central states, and in order to provide manufacturers in these states with the maximum amount of field and applications engineering experience in resistance welding, Louis M. Benkert and Paul Duer have announced the formation of Benkert and Duer, Inc.

The new organization will maintain three offices—in Columbus 2, Ohio (4820 Olentangy Blvd.); Cleveland 14, Ohio (859 Leader Bldg.); and Indianapolis, Ind. (325 Bankers Trust Bldg.). Benkert, who has resigned as General Sales Manager of Progressive Welder Co. to enter the new setup, and Paul Duer, who has been representing Progressive in Western Pennsylvania and Eastern Ohio, will make their headquarters in Columbus.

Art Johnson who has resigned as Chief Electrical Engineer of Progressive, will be in charge of the Indianapolis office, while George Omelianoff, also formerly with Progressive as applications engineer, will be in charge of the Cleveland office.

The new organization will specialize in resistance-welding equipment and will represent Progressive Welder Co. exclusively in Ohio (except Toledo), Western Pennsylvania, Northern Kentucky and West Virginia and most of Indiana. All are members of the AMERICAN WELDING SOCIETY.

ELECTRODE FOR POOR FIT-UP WORK

A new electrode, "Hobart No. 12," designed to increase welding speed on poor fit-up work, has been announced by Hobart Brothers Co., Troy, Ohio.

A heavy coated electrode designed for d.-c. straight polarity or a.-c., at higher current ratings to increase welding speed on poor fit-up jobs. At higher currents, the spatter loss of this electrode is unusually low and there is less tendency to stick when welding with a close arc.

This electrode is available in $^3/_{32}$-, $^1/_8$-, $^5/_{32}$-, $^3/_{16}$- and $^1/_4$-in. diameters.

FATIGUE BULLETINS

The Baldwin Locomotive Works, Testing Equipment Dept., Philadelphia 42, Pa., announces six new bulletins that describe and illustrate eight of its fatigue test machines:

Bulletin 260, 4 pages. Includes the R. R. Moore and much larger NEW Sonntag SF-10-R rotating beam types, Sonntag Universal Models SF-01-U, SF-1-U, SF-20-U, and SF-4, Sonntag SF-2, and Lazan Oscillator.

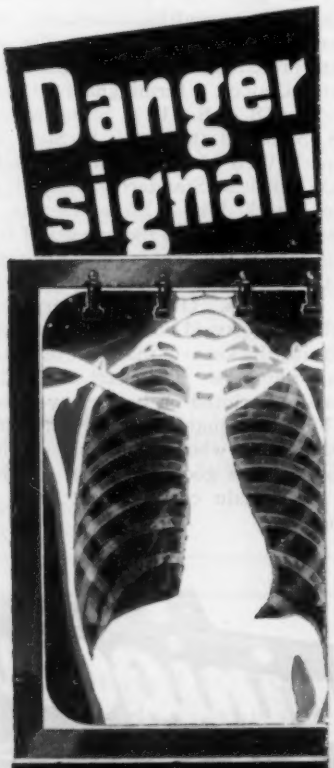
Bulletin 259, 4 pages. Sonntag SF-10-R Rotating Beam Machine of 10,000 in.-lb capacity (bending moment) designed to test large specimens (1 in. diameter at 100,000 psi.).

Bulletin 258, 8 pages. Sonntag Universal Models SF-01-U and SF-1-U, constant load types, and standard fixtures for testing materials, machine elements and structural components in tension, compression, bending, torsion or combined stresses up to 200 lb. and 2000 lb., respectively.

Bulletin 257, 4 pages. Sonntag SF-20-U Universal Fatigue Machine, constant load type for testing materials, bulky machine elements and structural components in tension, compression, bending, torsion or combined stresses up to 20,000 lb.

Bulletin 268, 2 pages. New Sonntag Model, SF-4 Fatigue Machine, the first constant force machine for measuring fatigue at elevated temperatures. For testing in tension and compression up to 10,000 lb.

Bulletin 256, 4 pages. Sonntag Model SF-2 Fatigue Machine, a small bench model, constant force type unit for testing sheet materials in flexure under repeated bending moments with alternating forces up to 20 lb.



DO YOU KNOW . . . that in America today there are approximately 250,000 people with "unknown cases" of tuberculosis?

. . . that these "unknown cases" are a major reason why TB still kills more Americans between 15 and 44 than any other disease — as they unwittingly spread infection, maybe to you, yourself, or a loved one?

. . . that the surest means of discovering TB early, before it spreads, is the chest X-ray?

. . . that your Christmas Seal money buys X-ray units and makes possible mass examinations?

PLEASE, send in your contribution today.

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Because of the importance of the above message, this space has been contributed by

AMERICAN WELDING SOCIETY

How a NI-ROD build-up saved a 3-month lay-up

From Canada comes the story of how the cast iron main gear of a big power shovel, made in England, had stripped 74 of its 76 teeth.

Getting a new gear meant a delay of 3 to 4 months... and the shovel was urgently needed. So, the owners called the Bowers Machine Company of Canada to repair the present gear.

Welding seemed the only solution. But, cast iron welds were generally considered risky propositions. So, Bowers turned to G. D. Peters and Company, Ltd. for their opinion.

Yes, indeed, Peters' men reported, it was possible to build up this gear. But, it called for careful control... and a high quality Nickel-cored electrode called Ni-Rod.

See below the step-by-step picture story of how this unusual job was done.

1 After degreasing in carbon-tetrachloride, and a thorough cleaning, the damaged teeth were ground down to offer a smooth surface for welding. Where teeth were broken off flush, holes were drilled in the rim and tapped. Studs were then inserted to lend extra support to the new teeth.

2 Before welding, the heavy cast gear was suspended over a temporary oven and heated with an oil torch to 600° F. This eliminated stresses and the possibility of cracking. The welding electrode used was ⅛" Ni-Rod at 95 amperes. After making one pass on one tooth, the gear would be given a quarter turn to assure even distribution of the welding heat.

3 This photo shows finished Ni-Rod "build-ups" on 6 of the teeth. To cut down machining time, tooth-size formers were used to enable the welder to gauge the depth of his deposit. These formers were of brass because Ni-Rod does not fuse with that metal.

4 After the gear had gradually cooled overnight in a low coke fire, the work of milling and machining began. Above illustration shows teeth being milled into Ni-Rod deposits. This work, says Bowers, proved to be easier than expected because the Ni-Rod deposits machined perfectly. Thus, instead of a 3 or 4 month lay-up, the excavator was back on the job in less than 2 weeks.

*Reg. U. S. Pat. Off.

Ni-Rod comes in 3/32" to 3/16" diameters. Order a 5-lb. package and you'll agree it's the solution to any cast iron welding problem calling for strong, crack-free, machinable joints. *Write for free Ni-Rod instruction booklet.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
INCO NI-ROD TRADE MARK

GET NI-ROD FROM:

Whitehead Metal Products Company, Inc.
Steel Sales Corp. — Williams and Company
Pacific Metals Company, Ltd. — J. M. Tull Metal & Supply Co.
Eagle Metals Co. — Metal Goods Corporation
Robert W. Bartram, Ltd. — Alloy Metal Sales, Ltd.
Wilkinson Company, Ltd. — Metal & Thermit Corporation
Hollup Corporation — National Cylinder Gas Company

RESEARCH AWARD

The American Society for Metals recently announced that Charles R. Hook has been elected to receive the Society's Medal for the Advancement of Research for 1947. Mr. Hook is president of the American Rolling Mill Co., Middletown, Ohio.

Qualifications for the candidate for receipt of this award do not specify that any one research achievement shall be the basis for awarding the honor. W. H. Eisenman, national secretary of A.S.M., stated that "rather the candidate shall be an executive in an industrial organization the principal activity of which is the production or the fabrication of metals. He shall be one, who, over a period of years, has consistently sponsored metallurgical research or development and by his foresight and his influence in making available financial support has helped substantially to advance the arts and sciences related to metals."

The medal, first awarded in 1943 to Roy A. Hunt, president of the Aluminum Co. of America, has been won in succeeding years by Robert C. Stanley, president of the International Nickel Co.; Gerard Swope of the General Electric Co.; and in 1946 by Rufus E. Zimmerman, vice-president, the United States Steel Corp. of Delaware.

Award of the medal, plaque and citation was made at the annual banquet of the American Society for Metals held in Chicago on October 23rd during the National Metal Congress and Exposition, principal international event of the metals industries.

Mr. Hook, was born in Cincinnati, Ohio, and attended the public schools of that city. He began his career in the steel industry in 1889 as an office boy. Joining the American Rolling Mill Co. in 1902, he was elected its president in 1930. He is chairman of the board of the Armco International Corp. and member of the board of directors of the Westinghouse Electric Corp., the C.C.C. & St. L. Railroad and the Equitable Life Assurance Society of the United States.

Mr. Hook served as president of the National Association of Manufacturers in 1938. At present, following a term as chairman of the board of that organization, he is an honorary vice-president as well as a director of the N.A.M.

Although unable to attend a college or university in his youth, Mr. Hook has received honorary degrees from the Michigan School of Mining and Technology, Ohio State University, Oglethorpe University and Stevens Institute of Technology. He is a member of the Corporation of Massachusetts Institute of Technology.

From 1938 until the present time, Mr. Hook has served in numerous important advisory capacities to the federal government both at home and abroad. He is currently a member of the Business Advisory Council of the U. S. Department of Commerce and also serves as a member of the National Industrial Conference Board.

Despite his numerous and varied industrial activities, Mr. Hook has devoted a large part of his life to cultural and recreational activities, particularly those beneficial to American youth. For many years he has actively participated in the Boy Scouts of America Movement and is a member of the National Council of that organization.

HARD-SURFACING FOR EQUIPMENT SALVAGE

An 8-page technical bulletin, which describes for the first time specific procedures involved in industrial equipment salvage welding with various gas and arc rods for producing hard overlay at low temperature, has just been issued by Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y.

Several interesting new alloys for the hard overlay process are featured analytically by means of charts, data and photographic illustrations of the case-history type. Broad service classifications have been designed to make this bulletin a handy reference for those interested in the economics of repairing worn equipment and in solving problems of abrasion, impact, cutting wear, corrosion and friction. Copy will be mailed on request. Ask for "Eutectic Welder: Overlay Issue."

FELLOWSHIPS FOR RESEARCH

Aid to college and university graduates who wish to undertake or continue research work in scientific and industrial fields was announced recently by the General Electric Co. for the 24th consecutive year.

Applications now are being accepted for the scholastic year 1948–49 for grants under the $1,000,000 G-E Educational Fund, from the income of which the fellowships are awarded, according to W. W. Trench, company secretary and chairman of the Education Committee.

The Educational Fund was established in honor of two former General Electric presidents. The Charles A. Coffin Foundation, named for the company's founder and first president, and the Gerard Swope Foundation, provide more than $15,000 annually for research fellowships. Since 1923, when the Coffin Foundation was established, 179 awards totaling $129,000 have been granted 147 individuals.

Applications for the fellowships, which must be filed by January 1, 1948, have been distributed to libraries of engineering schools, department heads of electrical and mechanical engineering schools, professors of electrical and mechanical engineering, physics, chemistry and metallurgy, and deans of graduate schools.

The Charles A. Coffin Fellowships are awarded in the fields of electricity, physics and physical chemistry. The Gerard Swope Fellowships, first granted in 1946, are awarded in fields of industrial management, engineering, physical sciences and any other scientific or industrial field.

Individual fellowships, Mr. Trench explained, will be for the amount needed up to a maximum of $1500 annually for each individual. A grant of $500 may be made for specific apparatus or other expense in connection with the research work. In addition, in case of need, loans up to $1000 may also be made.

Fellowships are intended for graduates who need financial assistance, and who have shown by the character of their work that they could with advantage undertake or continue research work in educational institutions either in this country or abroad. They are not intended, Mr. Trench said, for graduates who now hold, or expect to hold, any other fellowship which carries a stipend larger than the tuition at the institution where the research work is to be done.

Applications, which may be obtained from A. D. Marshall, secretary, General Electric Educational Fund, Schenectady, N. Y., will be passed on by a committee representing the National Academy of Sciences, American Chemical Society, American Physical Society, American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Society for Engineering Education.

LINCOLN FOUNDATION APPOINTS EDITOR-IN-CHIEF FOR NEW BOOK "DESIGN FOR WELDING"

E. E. Dreese, Chairman of the Board of Trustees of The James F. Lincoln Arc Welding Foundation, recently announced the appointment of R. S. Green of the Department of Industrial Engineering of Ohio State University as Editor-in-Chief of the Foundation's new Book, *Design for Welding*.

Design for Welding will be a comprehensive survey of the latest developments in the science of welded design in every major field of industrial operation. It will be based on the outstading papers submitted in the Foundation's $200,000 Design-for-Progress Award Program which closed June 1947, the results of which will be announced in the near future. In addition to forming the basis for the book, the award papers will be bound and placed in the A. F. Davis Welding Library at Ohio State University where they will be available for general use by industry.

In announcing the appointment, Dr. Dreese stated that Professor Green in editing this work will be able to draw from an extensive and varied experience in industry as well as teaching. He will also have as consulting editors leading industrialists in several fields.

Professor Green is in charge of Ohio State University's 5-year course in Welding Engineering which is the only course of its kind in this country leading to a graduate degree in Welding Engineering. He is a native of Muncie, Ind., and after attending high school there received his Bachelor of Science in Civil Engineering at Purdue University. After graduating in 1936 he was employed successively by the American Bridge Co., the Sinclair Refining Co. and the Carnegie-Illinois Steel Co.

In 1938 he returned to Purdue as an instructor in General Engineering and started his graduate work while carrying a

full teaching schedule. One of his assignments while at Purdue was to reorganize and teach courses in welding and heat treating. He continued until 1940 when he went to the Panama Canal Zone as Assistant Engineer (Structural) on the design of the Third Locks Project of the Panama Canal.

During 1941 and 1942 he was the resident engineer for the Blaw-Knox Co. on construction work being done by them for the Weirton Steel Company at Weirton, West Va. In February of 1942 the degree of Master of Science in Engineering was conferred upon him by Purdue. He accepted employment with Weirton in 1942 as a design engineer on various steel mill projects and remained until April 1947, when he was appointed an Assistant Professor at Ohio State University. Professor Green's stay at Weirton was interrupted from 1943 to 1946 by his appointment as an officer in the U. S. Navy, during which time he had special responsibilities in connection with welding work in the construction of submarines.

Professor Green is an Associate Member of the American Society of Civil Engineers, a member of the AMERICAN WELDING SOCIETY and of the American Society for Engineering Education. He delivered a paper before the combined Industrial and Mechanical Engineering sections of the latter society at their annual meeting in Minneapolis in June 1947, concerning instruction in welding at Ohio State University.

Publication date of *Design for Welding* has not as yet been definitely set, but it is hoped that the large amount of editorial work can be completed early in 1948.

HRUSKA BECOMES CONSULTING ENGINEER

John H. Hruska, until recently Director of Test and Inspection for Electro-Motive Division of General Motors Corp. at La Grange, Ill., has resigned. Mr. Hruska joined Electro-Motive in 1935 as Chief Metallurgist after previous connections with Carnegie-Illinois Steel Corp., International Harvester Co., Danly Machine Specialties, Inc., and Skoda Works, Ltd. During the war he was a member of the Ferrous Metallurgy Advisory Board, Committee on Welding of Armor. Mr. Hruska now serves several industries as Consulting Engineer, specializing in metallurgical and welding problems. His office and laboratory are in Hinsdale, Ill. Mr. Hruska is a member of the AMERICAN WELDING SOCIETY.

ENGINEERING COLLEGE RESEARCH COUNCIL

The Engineering College Research Council has just issued its "Proceedings of the Annual Meeting, 1947."

The Proceedings contain a number of papers which attracted favorable comment when they were presented at the annual meeting (June 17 to 21 in Minneapolis). The volume also contains reports of the Engineering College Research Council's activities for the year ending July 1, 1947.

Copies of the 1947 Proceedings are available, at the regular price of $1.00, from the Headquarters of the Research Council at the State University of Iowa.

SQUARE D ISSUES NEW DIGEST

A new Square D Digest, just issued, serves as a valuable source of reference and information on Square D equipment manufactured by both the Switch and Panel and the Industrial Controller Divisions.

This condensed catalog includes size, capacity and dimensional data, together with current prices. Although not all-inclusive in its coverage of the Square D line, it does include the Detroit Division's industrial safety switches, service equipment, Multi-breakers, industrial circuit breakers, Square Duct, Saflex Plug-in and Feeder Duct, lighting and power panelboards. Milwaukee Division products include a wide range of basic and related industrial motor control devices as well as a complete line of pressure, float and vacuum switches for water pump control. Also included in the new Digest are convenient tables for quick reference in proper selection of devices.

A copy of this new condensed catalog is available by writing the Square D Co., 6060 Rivard St., Detroit 11, Mich.

NEW WELDING ACCESSORIES AND SAFETY EQUIPMENT CATALOG

A new 40-page Catalog No. 22 of the Fibre-Metal Products Co., Chester, Pa., has just been published, showing a large diversified line available of welding helmets, hand shields, electrode holders, for electric and carbon arc, a weld-probing machine, protective clothing, welding cable, cable connectors, etc. An efficient method of supplying "Freshair" to welding helmets, a new line of scalemaster weld-cleaning hammers and scratchmaster steel wire brushes; together with many other new items.

This catalog is being distributed throughout the United States by the company's representatives. Contact your nearest distributor or write direct for your copy.

R. H. NEWTON APPOINTED MANAGER OF DEALER SALES

The impetus given arc welding by the war years has expanded the use of welding in the small manufacturing, service industry and agricultural fields to the extent that R. H. Newton has been appointed to a newly created office of Manager of Dealer Sales for The Lincoln Electric Co., Cleveland, Ohio.

The work of Mr. Newton will be to develop an organization to sell and service this mass market, and to that end he is now seeking new dealers.

R. H. Newton

The long-established Lincoln policy of selling to the industrial field through direct technical representatives will not be disturbed, and the policy of assisting manufacturers to design for welding through engineering service will be strengthened.

Mr. Newton has been brought to Cleveland from Minneapolis, Minn., where he was District Sales Manager, to franchise and organize welding equipment dealers throughout the entire country. To this task Mr. Newton brings 17 years' experience in the field for The Lincoln Electric Co. Before going to Minneapolis in 1937 he was active as a welding engineer in the Cleveland territory. He gained his experience in organizing dealers in Minneapolis where he created an extensive dealer set-up to help develop this large area. He now has 13 factory-trained men contacting prospective dealers. Mr. Newton is a graduate of the University of Michigan and is a member of the AMERICAN WELDING SOCIETY.

OBITUARY

S. K. Colby

Safford Kinkead Colby, 74, vice-president in charge of research and advertising for Aluminum Co. of America, died suddenly of a heart attack on Aug. 4th in Pittsburgh. He had just returned from a vacation trip to the West. A pioneer of the aluminum business, he had been associated with the progress of his company for more than 51 years, and was widely known throughout all American industry.

Born at Vallejo, Calif., in 1873, Mr. Colby received his early education in San Francisco schools, and was graduated from Rensselaer Polytechnic Institute in 1894 with a civil engineering degree. He joined the Pittsburgh Reduction Co. (which became Aluminum Co. of America in 1907) as assistant manager of its New York office in 1895. Later he became

S. K. Colby

manager of this office, and in 1905 was placed in charge of the company's Pacific Coast representatives.

He returned to the East in 1913, and two years later was appointed assistant general sales manager for the company, with headquarters in New York. In 1920 he was elected president of American Magnesium Corp., and in 1925 was made president of the American Body Co., then a manufacturing subsidiary of Alcoa at Buffalo. He remained at the Buffalo works for three years, during which time he was active in the promotion and development of the aluminum furniture industry.

Mr. Colby came to Alcoa's general offices in Pittsburgh in 1928, and was placed in charge of the sales promotion and advertising divisions. He became a vice-president of Aluminum Co. of America in 1931. The supervision of the Aluminum Research Laboratories was added to his duties in 1937.

Actively interested in the affairs of his alma mater, Rensselaer Polytechnic Institute, he served as president of the school's General Alumni Association, and since 1924 was a life trustee of the institution.

He was a member of the Duquesne Club, Pittsburgh; Engineers Club, Midday Club and Cloud Club, New York; Forest Lake Club of Hawley, Pa.; Edgeworth Club Sewickley, Pa.; and the Bohemian Club, San Francisco. His home was at 609 Academy Ave., Sewickley, Pa.

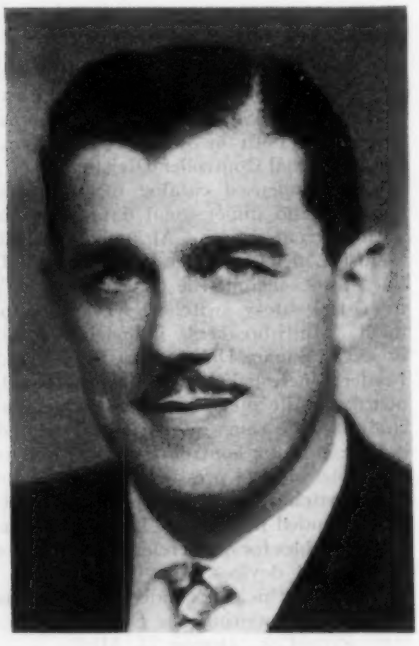
He is survived by his widow, Mrs. Harriett Tappan Colby, formerly of Troy, N. Y.; a daughter, Mrs. Suzanne Morrison Colby Heitmann of New York City; a son, Henry Gillett Colby, who is affiliated with Alcoa's Chicago District Sales office, and five grandchildren.

Mr. Colby was the son of the late Commodore Henry Gillett Colby, U.S.N., formerly Assistant Chief of the Bureau of Supplies and Accounts of the U. S. Navy, and the late Mary Cornelia Bronson Colby.

Mr. Colby was an active member of the Welding Research Council.

NORTHACKER BECOMES PRESIDENT OF METROPOLITAN PURCHASERS' ASSISTANTS CLUB

Alfred A. Northacker, Pipe and Tubular Products Buyer, The M. W. Kellogg Co., New York, N. Y., was elected President of the Metropolitan Purchasers' Assistants Club at their annual meeting held in the Midston House in New York City, on September 18, 1947.



A. A. Northacker

Mr. Northacker has been active in the work of the M.P.A.C. since 1944 and served as Chairman of the Educational Committee as well as Club Vice-President.

In addition to being a member of the above organization, he is an active member of the AMERICAN WELDING SOCIETY, American Society for Metals and the Office Executives Association of New York.

He has been connected with the M. W. Kellogg Co. since 1936.

1947–48 BOARD OF DIRECTORS, AMERICAN WELDING SOCIETY

President—H. O. HILL, Asst. Chief Engr., Fabricated Steel Construction, Bethlehem Steel Co., Bethlehem, Pa.

First Vice-President—G. N. SIEGER, Pres. and Genl. Mgr., S.M.S. Corp., Detroit, Mich.

Second Vice-President—O. B. J. FRASER, Director of Technical Service on Mill Products, The International Nickel Co., New York, N. Y.

District Vice-Presidents: #1 (New York & New England)—G. M. TREFTS III, Vice-Pres., Farrar & Trefts, Inc., Buffalo, N. Y.

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#5 (Mid-Western)—J. R. WIRT, Welding Engr., Delco Remy Div., G.M.C., Anderson, Ind.

#6 (Mid-Southern)—H. N. SIMMS, Metallurgist, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.

#7 (Western)—G. S. SCHALLER, Prof. Mechanical Engrg., University of Washington, Seattle, Wash.

Treasurer—R. S. DONALD, Sales Engr., Thomson Electric Welder Co., New York, N. Y.

Honorary Director—C. A. ADAMS, Consulting Engr., Philadelphia, Pa.

Directors at Large

Term Expires 1948:

C. H. JENNINGS, Westingfiouse Electric Corp., Buffalo, N. Y.

A. B. KINZEL, Union Carbide & Carbon Res. Labs., Inc., New York, N. Y.

C. M. UNDERWOOD, Northern Ordnance Co., Minneapolis, Minn.

R. D. THOMAS, Arcos Corp., Philadelphia, Pa.

*A. C. WEIGEL, Combustion Engineering Co., Inc., New York, N. Y.

Term Expires 1949:

D. H. COREY, The Detroit Edison Co., Detroit, Mich.

J. F. MAINE, Republic Structural Iron Works, Cleveland, Ohio.

E. L. MATHY, Victor Equipment Co., San Francisco, Calif.

L. S. MCPHEE, Whiting Corp., Harvey, Ill.

*W. F. HESS, Rensselaer Polytechnic Institute, Troy, N. Y.

Term Expires 1950:

D. ARNOTT, American Bureau of Shipping, New York, N. Y.

T. M. JACKSON, Sun Shipbuilding & Dry Dock Co., Chester, Pa.

C. I. MACGUFFIE, General Electric Co., Schenectady, N. Y.

J. B. TINNON, Metal & Thermit Corp., New York, N. Y.

*L. W. DELHI, California Steel Products Co., Richmond, Calif.

* Junior Past-Presidents.

Other Officers of the Society

Executive Secretary—J. G. MAGRATH, A.W.S., 33 W. 39th St., New York 18, N. Y.

Secretary—M. M. KELLY, A.W.S., 33 W. 39th St., New York 18, N. Y.

Journal Editor—W. SPRAGUE, A.W.S., 33 W. 39th St., New York 18, N. Y.

Technical Secretary—S. A. GREENBERG, A.W.S., 33 W. 39th St., New York 18, N. Y.

BOARD OF DIRECTORS MEETING

The meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held on September 18, 1947, in the A.S.C.E. Board Room, 29 W. 39th St., New York, N. Y., with the following present:

Members: R. W. Clark, D. H. Corey, O. B. J. Fraser, G. O. Hoglund, W. F. Hess, H. O. Hill, A. B. Kinzel, J. F. Maine,

H. M. Priest, R. D. Thomas, A. C. Weigel and G. N. Sieger.

By Invitation: E. V. David, Chairman, Convention Committee.

Staff: J. G. Magrath, Executive Secretary; M. M. Kelly, Secretary; W. Spraragen, JOURNAL Editor; S. A. Greenberg, Technical Secretary. The meeting was called to order at 10:15 A.M. by Acting Chairman Hill.

Finances

Report of the financial operations of the SOCIETY for the 11 months' period ended August 31, 1947, was briefed by Chairman Fraser. He drew attention to improvement in the SOCIETY'S net worth and total resources now, compared with a year ago. He reported an excess in income over expense at the end of the 11 months' period of $2644.64. It is his belief the year will close showing an excess of income over expense despite pessimism when the budget was in preparation last fall, and the prediction we would end the year with a deficit. This splendid showing he attributed to the promotional efforts and cooperation in effecting economies of the staff, the Publication Committee, Membership Committee and Technical Activities Committee. The Publication Committee and JOURNAL Editor were commended, especially, for the showing on the JOURNAL, which is particularly good compared with experience of other technical societies. He pointed out that the larger yield this year from the National Metal Exposition was helpful also.

The report covering financial operations of the SOCIETY, for the 11 months' period ended August 31, 1947, was accepted, with a vote of appreciation to the Chairman of the Finance Committee and to others responsible for the satisfactory financial position of the SOCIETY at this time.

Permanent Fund Special Committee

The Special Committee was commended for its achievement in adding $22,830 to the permanent fund, in view of the many difficulties encountered because of the war ending when the drive was in progress.

On recommendation of the Special Committee on Building Up Permanent Funds of the SOCIETY, the Board voted acceptance of report of the Special Committee, dated September 9, 1947, with sincere thanks to the members of the Committee for the effort and time spent on this work; further, the discharge, as of this date, of the Special Committee on Building Up Permanent Funds of the Society; and further, the publication in THE WELDING JOURNAL of list of contributors in the drive to build up the permanent funds of the SOCIETY, without mention of the amounts contributed.

Separate Welding Exposition

The Board voted: to discharge the Special Committees on Separate Welding Exposition, with an expression of appreciation for the efforts of the Committees; further, to accept the Special Conference Committee's recommendation that a stronger position in and larger returns to A.W.S. from the present setup with the National Metal Exposition be sought; and further, to appoint a new Special Exposition Committee, composed of three members, one favorably, and one unfavorably disposed toward a separate welding exposition, in addition to the Executive Secretary, and with scope not yet determined beyond that of exploring possibility of effecting a better arrangement than at present for participation in the National Metal Exposition; of studying further the desirability of the SOCIETY sponsoring a separate welding and cutting exposition; and with request that this Committee report its findings to the Board of Directors a year hence.

1947 Annual Meeting

Mr. David reported on accomplishments to date as follows: 600 rooms had been guaranteed by the Sherman Hotel management for housing the A.W.S. membership. Actually, 900 rooms have been reserved. Neither the Convention Bureau nor Mr. Eisenman fear a shortage of hotel rooms during the 1947 Congress.

The local activities are in capable hands. Mr. McFarland, with the assistance of Messrs. Boardman, Hansen and Goodwin, is handling arrangements for the President's Reception on Sunday evening. Mr. Seabloom is in charge of Dinner arrangements. Mr. Leverone, President of the Automatic Canteen Co., and a prominent speaker, has been secured as Master of Ceremonies. There will be music and entertainment during the Dinner but no dancing. The price of the Dinner has been set at $6.00 per person. Consideration is being given to plant inspection on Thursday afternoon, but arrangements have not yet been completed. The National Metal Congress management is arranging a program of entertainment for the ladies.

This year the Exposition will be open on Saturday and Sunday afternoons for executives of industry. Admission will be by invitation and registration badge. Special buses will be provided during the open hours of the Exposition for transporting members and guests of participating societies to and from the hotels to the exposition hall. Buses will run on schedule. Tickets can be purchased at Hotel.

To meet the wishes of the Manufacturers Committee, Mr. Spraragen, Secretary of the Program Committee, reported that the technical program had been shortened so as to allow free time for visiting exhibits. No technical sessions have been scheduled for Monday, Thursday and Friday afternoons. Adherence to rule that technical session papers be reviewed in advance of presentation has reduced the number of papers on the program.

In addition to regular Annual Meeting publicity program being carried out by the Publicity Committee, Mr. Magrath drew attention to plan for promoting interest in the Annual Meeting through an ad which will appear in the October WELDING JOURNAL. Special features of this ad are included also in an advance publicity leaflet on the Annual Meeting, being mailed to the membership on or about September 30th. Mr. Magrath stated it is planned to utilize a page in THE WELDING JOURNAL every month for the promotion of some phase of the SOCIETY'S activities.

A.S.M. Invitation for Participation in Future National Metal Congresses and Expositions

Communication from the Secretary of A.S.M. to the Secretary of A.W.S., transmitting a cordial invitation from the Board of Trustees of A.S.M. to the Directors of A.W.S. for participation of A.W.S. in the 1948, 1949 and 1950 National Metal Congresses and Expositions, was presented for consideration. The letter explained the necessity for making advance reservation of exposition and hotel space.

It was voted that invitation of the Board of Trustees of A.S.M. for A.W.S. participation in the 1948 National Metal Congress and Exposition, to be held in Philadelphia, October 23rd through the 29th, be accepted.

Technical Activities Committee

A.W.S. Representation on A.S.T.M. Committee A10—Iron Chromium, Iron Chromium Nickel and Related Alloys.—Voted to approve T.A.C. recommendation for appointment of S. A. Greenberg to replace L. M. Dalcher as A.W.S. representative on subject committee.

International Acetylene Association—Oxyacetylene Committee.—Voted to approve T.A.C. recommendation for appointment of S. A. Greenberg to replace L. M. Dalcher as A.W.S. representative on subject committee.

Appointment of Liaison Representative to Canadian Government Purchasing Standards Committee—Subcommittee on Metallizing.—Voted to approve T.A.C. recommendation for appointment of S. A. Greenberg as liaison member from A.W.S. on Metallizing to Government Purchasing Standards Committee—Subcommittee on Specifications for Metallizing.

Master Chart of Welding Processes.—Voted to accept T.A.C. recommendation that approval of the Master Chart of Welding Processes be tabled pending review of comments received.

Rules for Field Welding of Steel Storage Tanks.—Voted to approve T.A.C. recommendation for the approval of revision to Rules for Field Welding of Storage Tanks, and authorized a reprinting of the Rules.

Coordinating Committee on Research.—Voted to approve T.A.C. recommendation for disbandment of subject committee.

Filing Classification of Welding, Brazing, Soldering and Cutting Processes, Materials and Applications.—After discussion as to further need of this filing system, it was voted to approve T.A.C. recommendation for the withdrawal of this filing system, for the reason it is very much out of date and it is the opinion of T.A.C. that revision of the system is not a function of A.W.S.

Honorary Membership

The name of John J. Crowe was presented for Honorary Membership. It was voted that John J. Crowe be unanimously elected an Honorary Member of the SOCIETY for his achievements in research and development of oxyacetylene welding and cutting apparatus.

Amendment of Article V., Section 6, A.W.S. By-Laws—"Requirements of an Active Section"

It was voted to amend Article V, Section 6, of the By-Laws, to read: "No Section shall be considered active unless it holds at least three meetings during a *fiscal* year."

Confirmation of Appointment of A.W.S. Representative at International Welding Conference

It was voted to confirm appointment of H. R. Pratt, of the American Bureau of Shipping, as our representative at the International Welding Conference, in London, September 11–12, 1947. Mr. Pratt wrote that he would report to the SOCIETY on the Conference at the earliest moment.

Rules Governing the Award of the Lincoln Gold Medal

It was voted to approve proposed revision of rules governing the award of the Lincoln Gold Medal. As amended the rule now reads: "For the author or authors to be eligible for this award, the paper shall have been published in an issue of THE WELDING JOURNAL during a twelve-month period ending with the July issue before the Annual Meeting."

Services of President and Directors Appreciated

In a vote, the Board of Directors acknowledged its sense of appreciation for the valuable services performed this past year by President Delhi and, in his absence, by Vice-President Hill.

In turn, Mr. Hill, in behalf of President Delhi, thanked the Board for its loyalty and wisdom in the performance of their task.

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 10, D. C.

2,426,653—BRAZING NUT AND BOLT—Roderick J. Whelan and Robert A. Reich, inventors, Berea, Ohio, assignors to The Ohio Nut & Bolt Co., Berea Ohio. (3 Claims)

In this patent, a brazing nut or the like is covered, which nut has a layer of brazing metal fused to one of its surfaces. A solidified glassy layer of flux is fused upon and overlies the brazing metal.

2,426,746—APPARATUS FOR WELDING VANES TO TURBINE ROTORS—Nathan C. Price, Hollywood, and Harold A. Greenwald, West Los Angeles, Calif., assignors to Lockheed Aircraft Corp., Burbank, Calif. (14 Claims)

Special apparatus for use in positioning impeller blades so that they can be welded to a rotor drum is disclosed in and protected by this patent.

2,426,964—ELECTRONIC ARC WELDER—Edwin M. Callender, Cynwyd, Pa., inventor, assignor to The Budd Co., Philadelphia, Pa. (8 Claims)

This patent relates to an arc welder system wherein a transformer, having a center tap thereon, and rectifying tubes, each having a cathode and an anode, are connected across the transformer with the cathodes joined together in opposition. The welding electrodes and a reactor are connected in series with each other between the center tap of the transformer and the cathodes of the tubes to form a branch circuit through which current is transmitted from each rectifier in succession on the application of power to the transformer. Switching means are provided for shifting the connection of the branch circuit from the transformer center tap through the anode of one of the rectifier tubes so that the reactor can be made effective to discharge through the tube including such anode.

2,427,002—ELECTRODE HOLDER—Percy Jepson, Oakland, Calif., inventor. (7 Claims)

Jepson's holder has a member movable with the electrode to dispose it at a predetermined angle relative to the body. Positive stop means are associated with this member to contact the electrode and prevent endwise movement of same into the holder. Manually controlled means are associated with the holder for locking the movable member and electrode in the electrode holder.

2,427,466—ROD HOLDER—Richard T. Lawry, Richmond, Calif., inventor. (1 Claim)

The patented welding rod holder has a conductor rod which carries a square spindle. A head member receives the welding rod and is engaged with the spindle by a clamping nut that effects longitudinal movement of the spindle relative to the welding rod.

2,427,588—APPARATUS FOR BURNING HOLES IN METAL—Henry J. Burnett, East Hartford, Conn., inventor, assignor to United Aircraft Corp., East Hartford, Conn. (2 Claims)

Burnett's apparatus forms precision holes in hardened metal and includes an elongated electrode which has an electric potential applied between same and the metal to establish an arc therebetween, and means for vibrating the electrode axially so as to interrupt the arc rapidly. The vibration period of the electrode can be varied and cooling fluid can be directed onto the seat of the arc on the metal to remove metal freed by the arc.

2,427,696—WELDING MACHINE—Louis Trombetta, New York, N. Y., inventor. (2 Claims)

A special type of welding machine comprising a carriage with a casing thereon and an elongated member which is adjustably positioned with respect to the casing is covered in the patent. The guide arm is secured to the elongated member and its angular relationship with respect to such member is controlled by links mounted on the casing.

2,427,894—ELECTRODE HOLDER—Charles E. Benner, Grosse Pointe Woods, Mich., inventor, assignor to Mott Steel Products Co., Detroit, Mich. (7 Claims)

Benner's holder has a tubular handle which is secured to a cable terminal within the handle by a screw. A resilient band is carried by the handle for insulating the screw head and a tubular extension extends forward from the cable terminal and receives a rod therein. A cap is associated with the rod and engages with the tubular extension for controlling the electrode position.

2,427,966—WELDING ELECTRODE COATING COMPOSITION—Carl Jonathan Hirschler, New Malden, and William George Campbell, Aylesbury England, inventors. (2 Claims)

The patented coating composition includes lignocellulosic material wherein the lignin comprises about 36 to 70% of the material. A binding agent also is present.

IN 1936, eleven years ago, Machlett introduced the Thermax—the first shock-proof X-ray tube to combine in one unit radiographic, superficial and intermediate therapy applications. During the years since, it has made an outstanding contribution in these fields, giving the user a broadened field of techniques with minimum investment. The demand for tubes of this type or units of similar design offering even greater capacity, has been beyond our early expectations. As a result of this extensive experience, much additional knowledge was gained, which has enabled Machlett to completely redesign the tube. All the newest improvements have been incorporated without changing the external dimensions, and thus the tube can be used as a replacement in your present equipment.

The same small-sized housing is retained, rotatable through 360°. Strength has been increased at vital points. The new features increase the ruggedness and improve the function of the mechanical and electric internal structures.

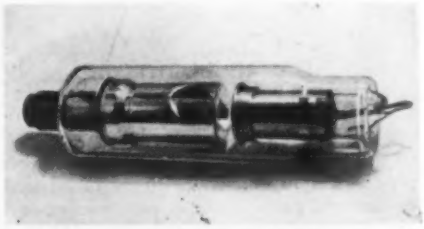
COOLING Heat dissipation is substantially increased: Two models: water-cooled and oil-cooled. Latter now features a new system of supplying the oil in a highly efficient jet discharge. Metal in cooling system is corrosion-proof super-nickel.

INSERT: Redesigned for more efficient operation. Closed hood with beryllium window surrounds target; space within tube is field-free, minimizing wall bombardment and stem radiation.

SHIELD: Ray-proofing by a heavy copper hood. A lead-loaded bakelite shield insures greater electrical stability and inhibits internal scattering.

Full details of this outstanding contribution to an important and growing field will be sent on request. Write Machlett Laboratories, Inc., Springdale, Connecticut.

150 PKV Industrial Thermax
20° target angle, available with single focus B spot, either water-cooled or forced-air-cooled.

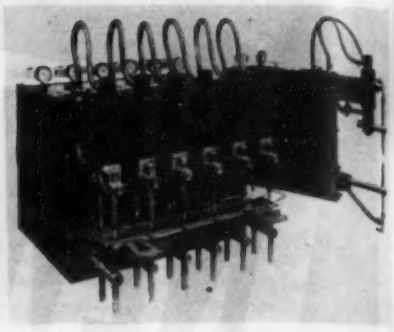


The new, improved Industrial Thermax Insert

MACHLETT
X-RAY TUBES SINCE 1897
TODAY THEIR LARGEST MAKER

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section



LARGE WHEELS FOR LYON-RAYMOND HYDRAULIC ELEVATING TABLE

For conditions requiring larger wheels (uneven floors, etc.), LYON-Raymond Corp. is now prepared to offer 10-in. diameter by 2-in. face semisteel wheels in place of the 5-in. rigid casters regularly furnished on the Hydraulic Elevating Table.

The axle bracket is designed for attachment to the base plate by the same bolt holes as used for the rigid caster and may be furnished for any table already in use that is equipped with 5-in. casters as well as on new equipment.

The larger wheels extend beyond the table top only 3 in. on each side, making the overall width, including wheels, 36 in. They do not extend in front of the table.

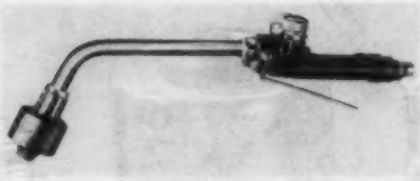
Full particulars can be obtained from LYON-Raymond Corp., 4221 Madison St., Greene, N. Y.

GAS-AIR BLOWPIPE

Weldit, Inc., announce that their Weldimatic Model C-47 gas-air blowpipe is now in quantity production. This new blowpipe is designed for use with manufactured or natural gas, propane and compressed air on heating, annealing or soldering operations.

The new C-47 blowpipe, of special aluminum alloy, combines the features of the original Weldit blowpipe—the first automatic gas-air blowpipe—and the Weldit C-46, with the added advantage of lightness of weight, increased capacity, and improved balance and grip.

The C-47 Weldimatic blowpipe cuts gas and air cost by automatically reducing the flame to a small pilot light during idle moments. When the operator grasps the



handle to resume work, the blowpipe relights instantly at the original adjustment.

The amount of gas and air saved depends on the job in hand. Some work calls for almost continual application of heat; on other jobs the flame is used only for a fraction of the operator's working time. Weldit C-47 saves this gas and air, ordinarily wasted. It eliminates the danger of the open, unattended flame with its accident hazard. It also reduces to a great extent the heat thrown off by the ordinary nonautomatic blowpipe.

The new model provides an exceptionally comfortable grip for the operator, with improved accessibility of valves and seat adjustments.

The Model C-47 is not the ordinary tube type of blowpipe, but is designed and built to close engineering standards.

The longer lever provides for easy flame control regardless of the position in which the blowpipe is held. Special control adjustments compensate for fluctuating gas and air flow both on the pilot light and main flow.

Inquiries may be addressed to Weldit, Inc., 990 Oakman Blvd., Detroit 6, Mich.

NARROW SPOT WELDER CAN BE GANGED FOR MULTIPLE WELDS

Suitable as a general-purpose bench-mounted welder, or ganged for multiple production, this automatic spot welder manufactured by Metron Instrument Co., 432 Lincoln St., Denver 9, Col., is complete in itself. Although only 4 in. wide, each unit incorporates controlled air-operated electrode pressure, adjustable current setting, electronic timing, water cooling of the transformer and electrodes and automatic pressure initiation of current. As a general-purpose unit operational fatigue is virtually eliminated since a small foot-actuated air valve controls the complete welding sequence. Electrode pressure is adjustable from nothing to approximately twice the air line pressure. Welding current is automatically applied after the electrode pressure has reached a predetermined pressure setting which is adjustable from nothing to approximately 90 lb./sq. in. in cylinder pressure. The built-in electronic timer controls the current duration from $^1/_{30}$ sec. to 2 sec. A 4-position head control switch provides adjustment of current for light and heavy work. All controls are on the top surface for good visibility and ease of adjustment.

Nominal rating of the transformer is 8 kva., however, the units will easily weld two pieces of 12-gage steel. Units are normally supplied for 220 v., 60-cycle operation although they can be supplied for 440 v. Dimensions are 4 in. wide, 32 in. deep and 24 in. high with a 12-in. throat.

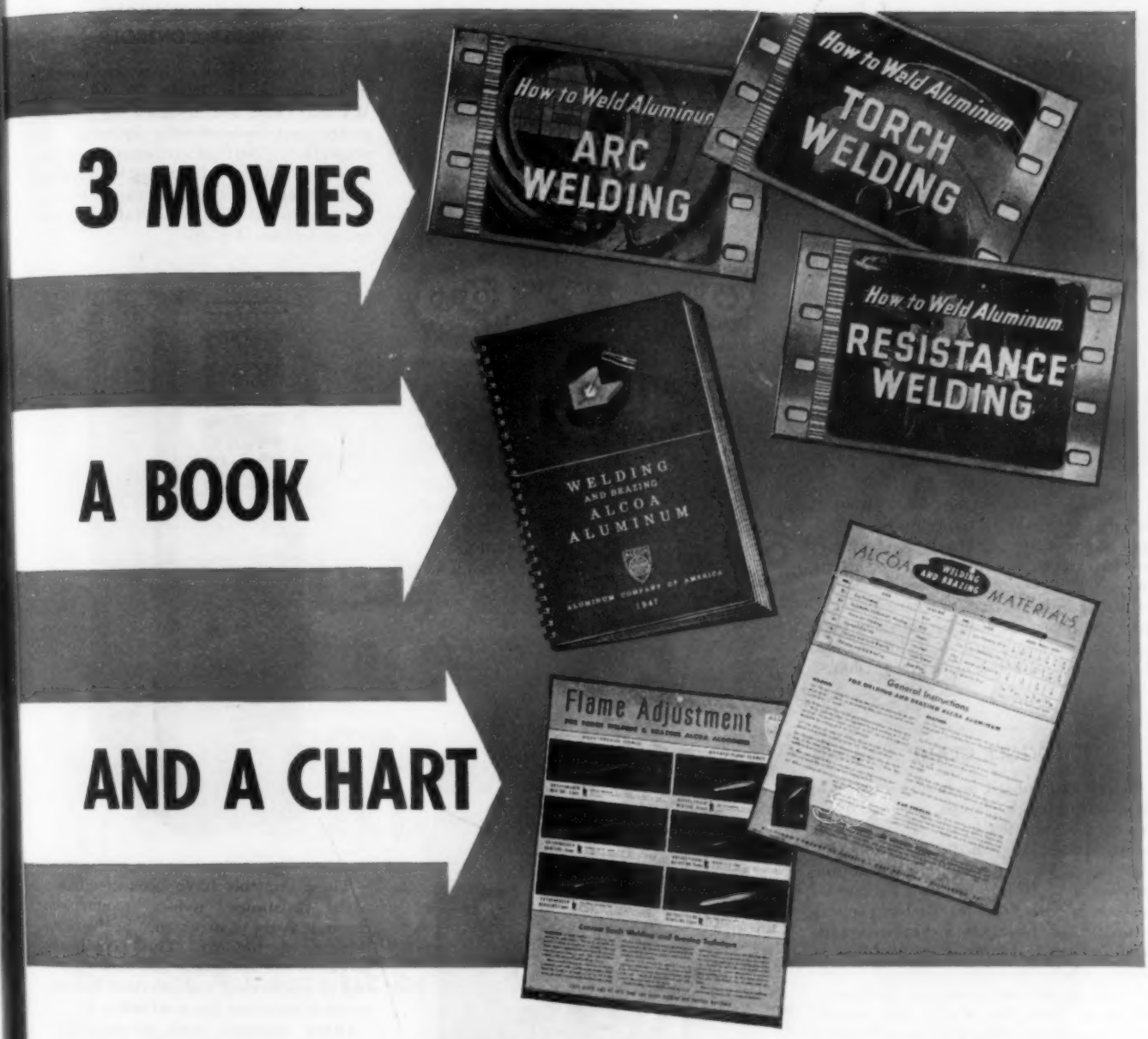
When ganged for multiple welds a single bank of these welders can be mounted for welding on 4-in. centers and two banks arranged face to face for welding on 2-in. centers. Multiple electrodes may be used in certain instances. Electrodes are pivotable to an off-center positon for special applications and both upper and lower electrode holders are readily adjustable to any position up or down of the front face of the machine. The welders can be operated upright, on their sides, or with the base upright to accommodate the work so that it is not necessary to position the work to the welder.

When operated in multiple, each welder can be adjusted for optimum condition whether or not all welds are with the same gage material and all units can be initiated by a common air valve. This provides complete control of each weld combined with automatic operation.

TRIPLE HEAD PROJECTION WELDER

The Federal Machine and Welder Co., Warren, Ohio, announces development of a new type welder designated as the Federal Special Triple Head Projection Welder for welding mounting brackets to cooling fins on compressor assemblies. With a machine cycle time of approximately five seconds the machine produces 150 assemblies per hour.

The welder is equipped with two locating current-carrying dies and one hydraulic cylinder operating clamp die. The three projection heads are hydraulically operated and incorporate spring clamping devices for locating the mounting brackets. The welding head dies incorporate an equalizer which insures equal pressure at all four projections. The welding heads operate in conventional type slides and are so arranged that the brackets are held to a tolerance of plus or minus 0.010 in. for the two different compressor mounting bracket sizes which the machine is capable



to help you make better welds in Aluminum

Here's help for welders, designers, and production men who are working with aluminum . . .

Three sound movies . . . "Arc Welding", "Torch Welding", and "Resistance Welding" are available for loan or purchase in both 16-mm. and 35-mm. widths from the nearby Alcoa Sales Office. These movies were made by aluminum welding experts to show your welders how to work with aluminum.

The booklet "Welding and Brazing Alcoa Aluminum" contains 109 pages of "how-to-do-it" information on all types of aluminum welding. Copies will be sent free on request.

An informative four-color wall chart . . . "Flame Adjustment" . . . shows actual photographs of welding flames suitable for various welding jobs. Suggestions to the welder are also included.

Ask your nearby Alcoa Sales Office for copies of the booklet and the chart. And ask them to schedule showings of the three movies for your shop people. ALUMINUM COMPANY OF AMERICA, 1933 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in 55 leading cities.

ALCOA FIRST IN **ALUMINUM**

IN EVERY COMMERCIAL FORM

ALCOA ALUMINUM

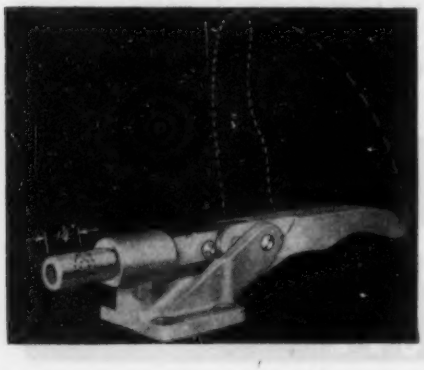
of welding. The water-cooled welding head dies are designed to permit an adjustment of the mounting bracket to facilitate location of both sizes of compressor assemblies.

Further information or complete machine specifications may be obtained from Department 14, Plant 2, The Federal Machine and Welder Co., Warren, Ohio.

TOGGLE CLAMP

Detroit Stamping Co., manufacturers of quick-acting toggle clamps, are in production on a new extra heavy duty plunger clamp, Model 640, called "The Ram" because of its great power and fast action. Capable of exerting over 2500 lb. normal pressure in tests, the Ram's outstanding feature is that the handle is down when the clamp is closed, desirable on machines or fixtures where space is restricted. Further, the operating motion is downward and away from the work; the heavily loaded handle provides split-second closing as merely tipping the lever will close the clamp with considerable pressure.

This new addition to the De-Sta-Co plunger clamp line, primarily a fast-acting holding device, is readily adaptable to such conversions as light arbor, punch and forming presses, for alignment of wood or metal parts in large fixtures, in batteries for laminating of beams or other heavy wood work, or for heavy-duty clamping of parts for milling, drilling, cementing, welding or other production operations requiring fast, uniform and powerful action.

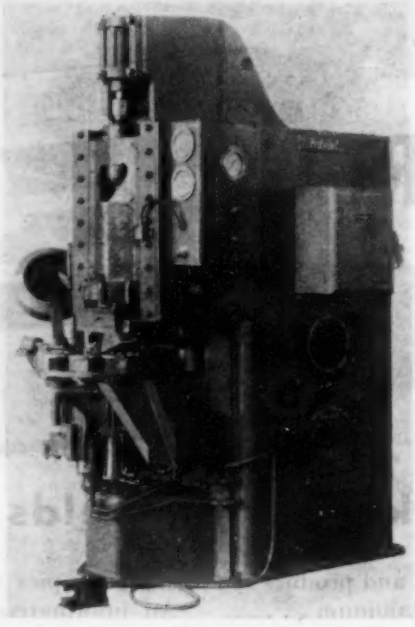


The Ram is $15^3/_4$ in. overall, $3^1/_4$ in. high, when closed. Plunger travel is $1^1/_4$ in. and pressure may be adjusted by turning $^5/_8$-in. bolt in the tapped end. The base is a rugged casting with bronze plunger bushing; toggle link is hardened steel and pins are drill rod. Write for details to Detroit Stamping Co., Dept. K, 322 Midland Ave., Detroit 3, Mich.

PRODUCTION PROJECTION WELDER

A new high-production welder, designated as the Federal PH4-12 Hydraulic Projection Welder, for welding gasoline engine push rod assemblies at the rate of 1200 per hour, is announced by The Federal Machine and Welder Co., Warren, Ohio, manufacturers of resistance welding and induction heating equipment.

The welded push rod assemblies consist of two parts, a round alloy steel disk which forms the head, and a forged steel cylindrical stem, containing a blind hole, the open end of which is projection welded to the disk.



The operator manually places the push rod in the die. The die moves around under the disk feed chute where the disk is clamped in place by a locator. The parts then move around under the welding head where the weld is completed while additional dies are being loaded. Upon completion of the weld, the dial feed mechanism rotates to the next station where the completed assembly is ejected into a chute and the next loaded die takes its position under the welding head. The welder is equipped with a 400-kva. welding transformer, having water-cooled, cast copper secondaries wound for 380-v., 60-cycle alternating current and is provided with 16-point series parallel heat regulation.

Further information or detailed specifications may be obtained by writing to Department 14, Plant 2, The Federal Machine and Welder Co., Warren, Ohio.

NONSYNCHRONOUS WELDER CONTROLS

These new nonsynchronous controls, manufactured by Taylor-Winfield Corp., Warren, Ohio, are designed for foot, air, motor and hydraulically operated spot, projection, butt and seam resistance welders. By manufacturing both controls and welders, this company can assume the entire responsibility for installation, service and renewal parts.

These controls have been coordinated with resistance welder requirements through years of experience in the manufacture of welders. This coordination produces the automatic and accurate control of mechanical and electrical functions which is necessary for good welds.

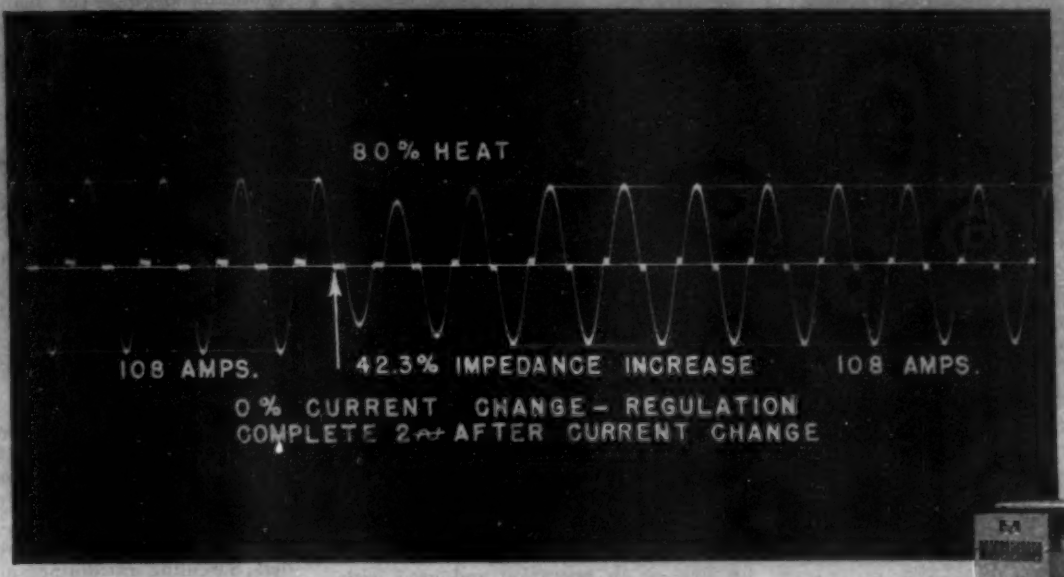
Other features, such as appearance, accuracy, accessibility and installation can be easily found in the bulletin issued by the manufacturer.

At the present time Taylor-Winfield is manufacturing a NEMA Type 1A Weld Timer, NEMA Type N2 and N3 combination controls (description may be found under photos in the bulletin).

SEAM WELDER

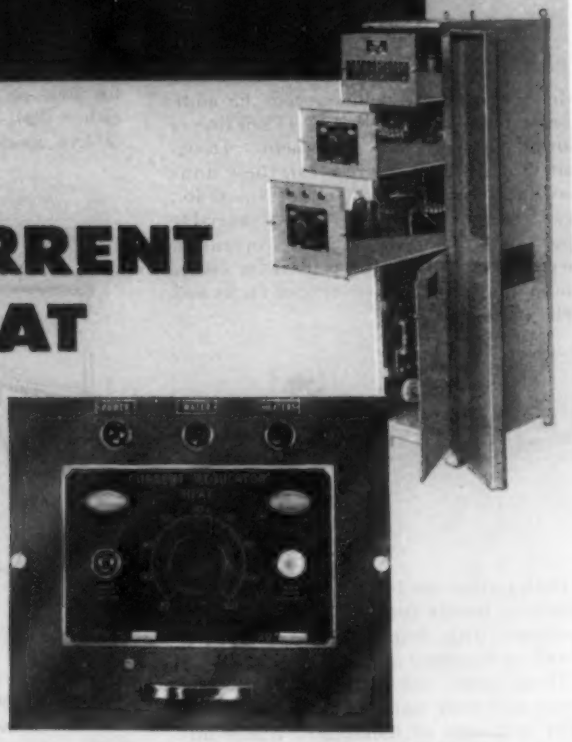
A new double roll traveling head series seam welder has been developed by The Federal Machine and Welder Co., Warren, Ohio, major manufacturer of resistance welding and induction heating equipment. Especially designed for use in strip mills and in other plants where it is desirable to join strip ends or skelps for long machine runs, the new 125-kva. welder unit makes any strip mill continuous. The machine is supplied in four standard sizes for welding 38-, 48-, 56- or 66-in. line either right handed or left handed.

The unit is of fabricated steel construction throughout. A notable feature is the change-speed gear which gives selective



Insure CONSTANT CURRENT and WELDING HEAT

...with this new RAYTHEON Type CR Automatic Regulator



RAYTHEON CURRENT REGULATOR, Type CR, provides uniform current for spot welds of 4 or more cycles, or seam welds of 3 or more cycles "on" time with any "off" time.

You can now produce uniform welds *irrespective of transformer impedance change . . .* by using the new Raytheon Type CR Automatic Current Regulator to insure a constant current.

This new unit maintains welding current within 2% of preset value . . . over an impedance range which normally causes a maximum 20% current change, and over a 20 to 80% power factor range. In addition, it automatically regulates for changes in line voltage.

Any machine equipped with Raytheon Synchronous Control can be quickly equipped with the Automatic Current Regulator by simply replacing the standard Phase Shift Drawer.

Write for detailed information on Raytheon Synchronous and Non-synchronous Controls

Bulletins DL-W-201 to 205J

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RAYTHEON MANUFACTURING COMPANY

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Industrial and Commercial Electronic Equipment
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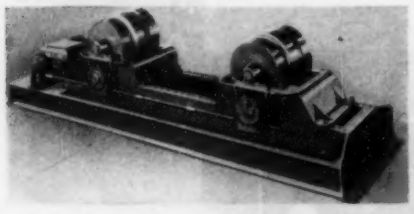
speed range of 10 to 27 ft. per minute or 20 to 54 ft. per minute.

Further information or detailed specifications may be obtained from Department 14, The Federal Machine and Welder Co., Warren, Ohio.

TURNING ROLLS

The Reed Engineering Co. of Carthage, Mo., have recently announced the addition of two new machines to their line of power turning roll equipment. Designated as Models 250 and 500, these units have capacities of 25,000 and 50,000 lb., respectively. Equipped with variable speed drive and remote control operating switch these units can be used for either manual or automatic welding of tanks and cylindrical shapes.

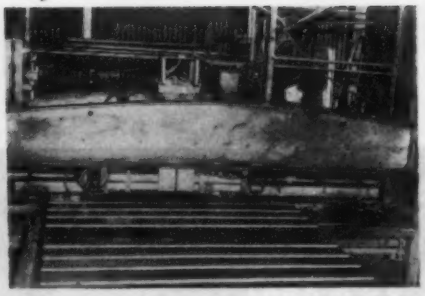


Both models are built with all steel construction, totally enclosed gearing and are equipped with heavy-duty rubber-tired wheels as standard equipment.

These units are built with separate power and idler units for increased flexibility and ease of handling. Where additional capacity is required, extra idler stands can be used which will give 50% additional capacity to the above ratings.

SEAM WELDING TRAILERS

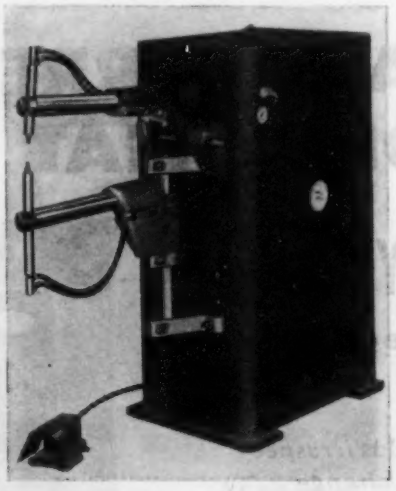
The accompanying photo shows one of the secrets why trailer manufacturers have been able to get such good production recently. This machine, a dual seam welder designed by Progressive Welder Co., Detroit, is turning out complete side and top panels for all sizes of trailers at the Fruehauf-Carter Division in Memphis, Tenn., of the Fruehauf Trailer Co. The panels are formed by lap welding together narrower panels to form the large weathertight panels, up to 9 ft. wide, and to any length desired. Use of two wheels cut the already short welding time in half, since half of each seam weld is formed by each



wheel as it rolls across the panel. It takes only a minute to make from 8 to 24 ft. of weathertight seam—depending on the thickness of the metal used in the specific panel.

50-KVA. SPOT WELDER

Announcement is made of a newly designed 50-kva. spot welder by Banner Products Co., 4961 N. 29th St., Milwaukee 9, Wis. If is engineered for maximum production speed without impairing quality of welds. The model shown is made for foot or air operation and used with either 220- or 440-v., 60-cycle current; 30-kva. models are also available.



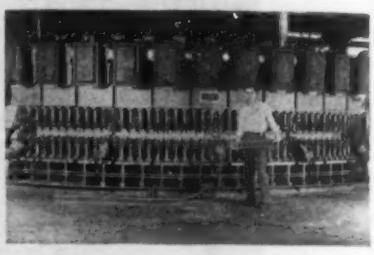
The 50-kva. contains such features as eight ranges of heat selection with easy to reach external adjustment, water-cooled transformer and high conduction, high-strength current carrying castings.

On long production runs where repeat operation is used the free action of welder and low inertia of rocker arm enable operator to positively space spots to produce a clean, uniform job. Unit is adaptable to a variety of jobs, an important feature that lends itself to both the job shop and the highly geared assembly line.

MULTIPLE-HEAD SPOT WELDER SPEEDS PRODUCTION OF QUONSET HUTS

The famous wartime "Quonset" huts are finding so many civilian uses that demand is far exceeding supply. Their adaptation to farm, home and industrial use illustrates the versatility of this sturdy, portable type of construction.

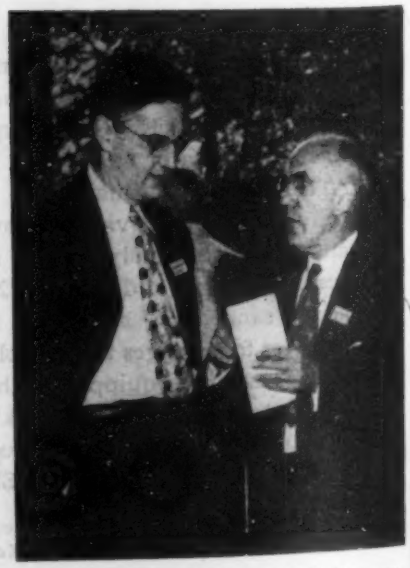
To help speed production, a giant multiple-head spot welder has recently been completed by Sciaky Bros., Inc., Chicago. This unit welds 88 spots to form the large curved joists. The operation is nearly simultaneous and the man-hours saved over rivet or torch-welded construction are easily apparent. Production rates under ideal conditions are better than one complete joist per minute.



The welder is rated 1000 kva. peak and welds two thicknesses of 11-gage steel. An unusual feature of the machine is its division into 11 units, each unit being a complete machine in itself. The unit is comprised of 16 hydraulic welding cylinders, 8 welding transformers and a hydraulic motor unit. This principle of subdividing the machine allows greater flexibility should changes in the length or contour of the joist occur. The hydraulic welding cylinders are provided with automatic adjustment for wear on electrode tips.

R.W.M.A. MEETING

This photo shown below was taken at a recent meeting of the Resistance Welder Manufacturers' Association.



Geo. N. Sieger (Right) of S.M.S. Corporation and President of the R.W.M.A. Talking with R. H. Taylor of Electroloy Co., Inc., During the September Meeting of the Resistance Welder Manufacturers' Assn. at The Taylor-Winfield Corp. Plant at Warren, Ohio

SECTION ACTIVITIES

BRIDGEPORT

R. F. Helmkamp of the Air Reduction Sales Co. spoke on "Machine Cutting" at the Sept. 18th meeting held in the Candlelight Restaurant in Bridgeport. Mr. Helmkamp's very interesting talk was illustrated with slides.

CINCINNATI

A plant inspection of the Precision Welder & Machine Co., manufacturers of all types of resistance welding machines, was held on Sept. 30th. Dinner was held in the Engineering Society Headquarters preceding the visit. The plant visit was of exceptional interest to members of the Cincinnati Section because different types of resistance welding machinery were in operation, including spot, portable and projection welders.

CHICAGO

The following is the program of meetings for the remainder of the season of the Chicago Section. Dinner will be served at 6:00 P.M., in the Mural Tap Room, 80 E. Jackson Blvd. Meeting will start at 7:30 P.M., People's Gas Auditorium, 122 S. Michigan Ave.

Nov. 21st—"Brazing and other Applications of High Frequency Heating," by Harold Bunte, Commonwealth Edison Co.

Dec. 19th—"Re-Design for Welding," by James F. Lincoln, The Lincoln Electric Co.

Jan. 16th—"Metallurgy and Welding of Alloy Steels," by Eric Seabloom, Crane Co.

Feb. 20th—"Welding in the Reclamation of Locomotive Parts," by G. E. Bennett, Chicago and Eastern Illinois Railroad.

Mar. 19th—"Maintenance Welding in a Steel Plant," by W. M. Presson, Carnegie-Illinois Steel Corp.

Apr. 16th—"Inspection of Welding"—a symposium.

May 21st—"Three-Phase Balance Load Resistance Welding," by William J. Farrell, Sciaky Bros. Inc.

CLEVELAND

Clarence E. Sims, assistant director of Battelle Institute, opened the 1947–48 season for the Cleveland Section at its first meeting of the year on Oct. 8th. Mr. Sims spoke on "Underbead Cracking in Metal Arc Welding," a subject which is of great interest at the present time, with the desire on the part of all Cleveland fabricators to weld steels which were formerly considered very difficult to weld.

"Nat" Howard, editor of the Cleveland *News*, was the "coffee talker" at dinner and spoke on "The World As It Is" in the original way for which he is well known.

COLORADO

G. N. Sieger, President, S-M-S Corp., spoke on the "Future Responsibilities of the AMERICAN WELDING SOCIETY" and "Resistance Welding," at the Sept. 8th meeting. Dinner meeting was held in the Silver Wing Inn, Denver. A film, "Designing for Arc Welding Structural Steel," was shown through the courtesy of The Lincoln Electric Co. Both paper and film were well received.

COLUMBUS

R. M. Wilson, Jr., presented a talk entitled, "The Welding of Nickel and High Nickel Alloys," on Friday evening, Oct. 10th, at the Fort Hayes Hotel.

The speaker presented a general discussion on the mechanical and physical properties of nickel, Monel and Inconel, stressing their particular characteristics which relate to welding. Problems encountered when joining these materials and when joining dissimilar metals by all common welding, brazing and smoldering processes were described.

Mr. Wilson is Welding Engineer, with the Technical Service Section of the Development and Research Division of The International Nickel Co., Inc., New York.

DAYTON

September meeting was held on the 24th at the Engineers Club. G. O. Hoglund, Welding Section Head of the Jobbing Division of Aluminum Co. of America, was the guest speaker. He discussed "Aluminum Welding," a subject of interest to everyone connected with the Welding industry.

DETROIT

Four hundred and fifty members and guests attended the plant visitation of the Kaiser-Frazer Corp., Friday, Sept. 12th. An afternoon and evening inspection tour of the entire automotive plant, while in operation, proved to be very interesting. Two showings of the movie, "The History of Building the Liberty Ships at Richmond Shipyard," were also of interest. Dinner was served in the Kaiser-Frazer Cafeteria, at 6:30 P.M.

HARTFORD

A dinner meeting was held on Thursday, Sept. 18th, at the University Club of Hartford. Speaker at the meeting was C. B. Voldrich, Chief Welding Engineer, Battelle Memorial Institute, Columbus, Ohio. His subject was "Weld Cracking in the Heat-Affected Zone."

The October dinner meeting was held on Thurs., the 16th, at the Whitlock Manufacturing Co. A. Leslie Pfeil, President, Universal Welder Corp., Cleveland, spoke on "Resistance Welding at Work."

Coming meetings of the Hartford Section are as follows:

Nov. 20th—"Tool and Die Welding."

Dec. 18th—"Selection of Electrodes for Welding Dissimilar Metals."

Jan. 15th—"Heliarc Welding."

INDIANA

The first meeting of the season was a Ladies Night on Sept. 26th at the Lincoln Hotel, Indianapolis. Dale G. Mason, Vice-President in Charge of Flights, Turner Aeronautical Corp., Indianapolis, spoke on "Aviation and Its Development."

INLAND EMPIRE

On July 22nd the Inland Empire Section toured the Mead Aluminum Reduction Works of the Permanente Metals Corp. under the able guidance of Howard Holmes, Public Relations Officer of Permanente. Mr. Holmes illustrated each phase of the production of aluminum from Bauxite by leading the group from one process to the next, in order that everyone might obtain a comprehensive view of the manufacture of aluminum ingots.

On Sept. 24th, a tour was conducted through the Trentwood Works of the Permanente Metals Corp. by Howard Holmes, Public Relations Manager of Permanente. Everyone present obtained first-hand knowledge of the fabrication of aluminum sheet and strip as a result of the visit.

KANSAS CITY

The Sept. 10th meeting of this Section was held at the Rex Welder Engineering Co. Dinner at Fred Harvey's preceded the meeting. G. N. Sieger, President, S-M-S Corp., Detroit, gave an extemporaneous talk on Resistance Welding and Future Responsibilities of the A.W.S.

LEHIGH VALLEY

The Lehigh Valley Section held its first meeting of the 1947–48 season on Oct. 6th at the Hotel Bethlehem, Bethlehem, Pa.

A large gathering of members and guests observed "Comfort A. Adams Night" and heard a talk on "Impulse Welding of Structural Steel," by Wendell F. Hess of Rensselaer Polytechnic Institute.

Dr. Adams, founder and first president of the AMERICAN WELDING SOCIETY, gave an informal talk on events leading to the

SOCIETY's founding. He told of the need of sound, logical and honest thinking, while obtaining accurate evidence in welding research.

Dr. Hess gave a very interesting report on the progress of a current research program on impulse welding of heavy gage steel of which he is in charge. Lantern slides were used to illustrate his talk.

LOS ANGELES

The first meeting of the season was held Sept. 18th. The meeting was opened by the new chairman, "Al" Fenlason, Welding Superintendent of Consolidated Steel, who gave a short introductory talk.

Al Fenlason

The speaker of the evening was Fred S. Boericke of Haynes Stellite, who presented a well-illustrated paper on welding methods and applications of "super" alloys. This included pictures and discussion of aircraft exhaust stacks, tail pipes, collector rings, turbo-superchargers and jet engines, as primary uses for these alloys.

Following this very interesting talk, the Southern California Gas Co. ran a short talking picture showing the manufacture, distribution and uses of natural gas.

LOUISVILLE

The first fall dinner meeting of the Louisville Section was held in the Junior Ball Room of the Seelbach Hotel, Sept. 23rd.

The new officers were introduced and the chairman talked on the past and future activities of the Section.

Frank J. Lammers, Secretary of the Wallace Supplies Manufacturing Co., Chicago, talked on "Welding Problems in Jet Propulsion." With lantern slides and blackboard sketches, Mr. Lammers gave an interesting and instructive account of how problems were solved on a war production job in welding stainless steel plate parts and eliminating excessive distortion.

MICHIANA

The opening meeting of the season was held on Friday, Sept. 19th, at the Bendix Legion Hall, South Bend, Ind. E. P. Auler, Taylor Forge & Pipe Works, spoke on "Low Temperature Stress Relieving with the Oxy-Acetylene Flame."

A film "Sail Fishing Off Gulf of Mexico" was also shown.

MILWAUKEE

Leslie S. McPhee, Welding Supervisor, Whiting Corp., Harvey, Ill., was the main speaker at the regular meeting held Friday, Sept. 26th. Mr. McPhee's subject, "Jigs, Fixtures and Production," is one on which he is a recognized authority and a lively discussion followed his presentation.

NEW JERSEY

The following is the schedule for the remainder of the meetings of the season.

Nov. 18th—"Turbo Jet Engines," by Everett Chapman, Consulting Engineer.

Dec. 16th—"Fabricating of Aluminum," by George Perkins, Reynolds Metal Co.

Jan. 20th—"Effect of Electrical Types and Current Characteristics of Welding Production," by A. G. Hogaboom, Bethlehem Shipbuilding Co.

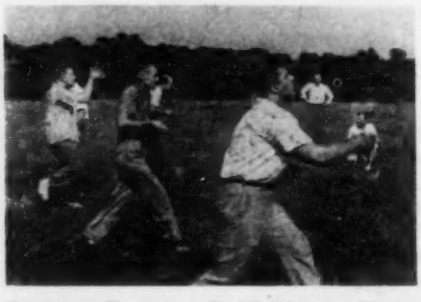
Feb. 17th—"Welding Power Piping," by Roger W. Clark, General Electric Co.

Mar. 16th—"Steels for Resistance Welding," by Dr. S. L. Hoyt, Battelle Memorial Institute.

Apr. 20th—"Welding of Nickel Steels for Low Temperature Service," by T. N. Armstrong, The International Nickel Co., Inc.

May 18th—Annual Meeting.

Annual social and get-together in the form of a Stag Picnic and Outing was held on Sat., Sept. 13th, at Farcher's Grove, Union, N. J.



Secretary-Treasurer P. M. Mattern Shows His Dexterity as an Egg-Catching Contestant

The weather was ideally suited to the occasion and the plans for the day unwound without a hitch. The following activities were participated in and enjoyed by all the participants: golf tournament, quoit pitching, bag throwing, egg catching, nailing, block pitching, three-legged race, etc., etc.

There were many first rate prizes for the winners and runners-up of each of the events. Beside those prizes put up by the New Jersey Section, there were many others donated by various supporting companies. All the prizes were previously wrapped and displayed on a table to picque the competitive spirits of the gladiators.

A turnout of approximately 250 made for a happy, frolicking, juniper junction outing which promises to be repeated again next year.

NEW YORK

In order to orientate the activities of the New York Section with the wishes of the majority of the members of the Section a questionnaire was sent out to all members. The replies have been carefully correlated and the meetings will be arranged accordingly. A majority of the members of the Section indicated that they wished to have the question and answer period resumed and this will be done at an early date.

The October meeting was held on the 8th in the Engineering Societies Building and was preceded by a dinner at the Engineers Club. The session started at 7:30 P.M. A. M. Unger, Chief Welding Engineer, Pullman Standard Car Mfg. Co., Chicago, presented a paper on "Production Welding of Passenger Railroad Cars." There was a considerable amount of discussion. The paper was presented in Mr. Unger's usual excellent style. The attendance was not large, but select. About seventy-five slides were shown.

NORTHERN NEW YORK

The Northern New York Section opened its fall program with a talk given by E. C. Brekelbaum, Executive Chief Engineer of the Harnischfeger Corp. Mr. Brekelbaum spoke at the Sept. 25th meeting held in Schenectady, on the subject "Coordination of Engineering and Production in the Manufacture of Welded Products."

Mr. Brekelbaum's talk which was filled with stimulating and constructive thoughts was excellently delivered and exceptionally well received.

The Section, under the leadership of its Chairman, E. N. Boswell, has a complete program already scheduled for each month through May 1948. This includes a special program for "Ladies Night," Nov. 20th.

In addition to the regular Section activities, informal round table discussions are held each month. Here the local welding talent congregate for refreshments, and discuss and solve the more perplexing everyday and future welding problems.

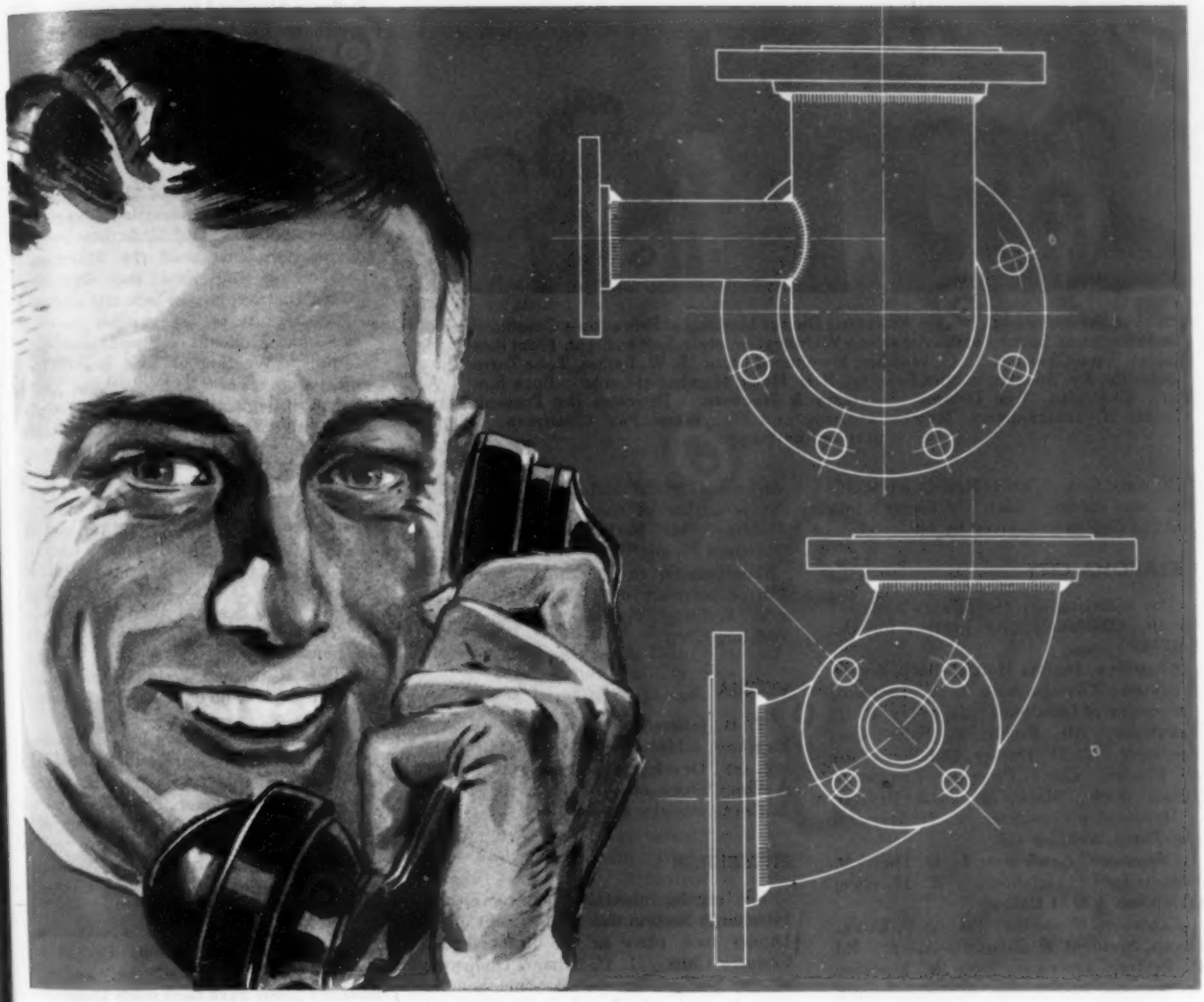
NORTHWEST

The first meeting of the 1947–48 season was held on Monday, Sept. 8th. A "Happy Half Hour" was held starting at 6:00 P.M., at which those present were guests of Chairman Ed Hall, who provided desirable refreshments.

The meeting was devoted to the solving of practical problems pertaining to welding.

NORTHWESTERN PENNSYLVANIA

The first meeting of the fall season was held on Tuesday evening, Sept. 23rd, at the General Electric Community Center, Erie, Pa. Social hour and dinner preceded the meeting. George N. Sieger, President and General Manager, S-M-S Corp., Detroit, was the speaker. A new



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Board of Directors and Speaker Attending Dinner Meeting at Pascagoula Country Club of the Pascagoula Section of the American Welding Society. Left to Right, Front Row: E. H. Holder, Vice-Chairman, L.G. Webber, Member-at-Large, E. W. Bethel, Tube Turns, Inc., Louisville, Ky. Speaker for the Evening, R. H. Macy, Member-at-Large. Back Row, J. A. Furr, Chairman, Tom Dawson, Secretary & Treasurer. Directors Not Present Were Claude H. Faulkenberry, Member-at-Large and Phil Ware, Past Chairman. Photographed by Stagg

G.E. color film, "This Is Resistance Welding," was shown. Both Mr. Sieger's talk and the film were enjoyed by all.

OKLAHOMA CITY

The following are the officers installed by the Oklahoma City Section for the 1947–48 season.

Chairman, Denver House, Black, Sivalls & Bryson; *Vice-chairman*, L. E. Dietrich, University of Oklahoma; *Secretary*, R. J. Trautman, Air Reduction Sales Co.; *Treasurer*, W. D. Brewer, Oklahoma Gas & Electric Co.; *Program Chairman*, James Wade, Black, Sivalls & Bryson.

Membership Committee: V. D. Harmon Big-Three Welding Co.

Educational Committee: L. E. Dietrich, University of Oklahoma; W. H. Rice, Oklahoma A & M College.

Executive Committee: James F. Craig, Ocean Accident & Guaranty Corp.; Ed C. Foster, American Iron & Machine Works; L. P. Stilwell, Mideke Supply Co.; L. D. Robson, Oklahoma Gear Works.

George N. Sieger, President of the S-M-S Corp. of Detroit, spoke on two subjects, one, "Resistance Welding," and the other, "Future Responsibilities of the AMERICAN WELDING SOCIETY." The General Electric film "This Is Resistance Welding" was shown.

PASCAGOULA

The Sept. 10th Dinner Meeting was held at the Pascagoula Country Club. E. R. Hammett, Controller, Ingalls Shipbuilding Corp., was Toastmaster at the dinner.

Carl N. Barlow, Engineer, Dept. of Water & Power, Los Angeles, was the speaker at the technical session. Mr. Barlow's talk was on "Welding As Applied to Power Plant Design." This was on the new harbor steam plant which is almost completely welded as to equipment, pointing out the great economy and higher quality job by welding.

The Pascagoula Section reports that it was extremely fortunate in having as speaker at their Oct. 8th meeting held in the Pascagoula Country Club, E. W. Bethel, of Tube Turns, Inc., Louisville, Ky. This was the 27th time this year that Mr. Bethel appeared before various technical and scientific societies. He is author of the book *Marine Pipe Welding*. Mr. Bethel's subject was "Modern Piping."

Toastmaster at the dinner was J. A. Furr, Chairman of the Section and General Welding Foreman, Ingalls Shipbuilding Corp.

PEORIA

T. B. Jefferson, Editor of *The Welding Engineer*, addressed the Sept. 17th meeting, on "Developments in Arc Welding." A film "Story of the Electrical Storage Battery" was also shown.

PITTSBURGH

The regular monthly meeting of the Pittsburgh Section was held on Sept. 17th. Dinner took place in the Brackenridge Country Club. H. P. Schane, Chairman of the Section, presented some general remarks and introduced G. O. Hoglund of the Aluminum Co. of America, and W. R. Grunow of the Allegheny-Ludlum Steel Corp. Two films were shown, one on "Stainless Steel" and the other on "Aluminum."

The meeting was devoted to a plant visitation sponsored by the Allegheny Ludlum Steel Corp., and the Aluminum Co. of America. Members were personally conducted through both plants and afforded an opportunity to witness at first hand the casting of stainless steel, rolling of sheets, etc., and the fabrication and welding of aluminum tanks, utensils and tubing.

ROCHESTER

Monthly dinner meeting of the Rochester Section was held on Thurday, Oct. 2nd. Dinner was cafeteria style at Todd Union, River Campus, University of Rochester. Meeting was held in Dewey Hall, University of Rochester. A. M. Unger, Chief Welding Engineer of Pullman-Standard Car Mfg. Co., described welding fixtures so huge they can handle entire sides and entire roofs of 85-ft. railroad passenger cars. He said that the enormous fixtures, the largest known in the world, are being used both in the Chicago and Worcester, Mass., plants of Pullman-Standard to aid in production of equipment for America's railroads.

A sound movie on the Navy twin jet-propelled fighter "The Phantom" was also shown.

SAN FRANCISCO

The September meeting was held on Monday, the 22nd, at the Engineers Club. John J. Hennessy, Manager of Public Relations, and E. L. MacDonald, Engineer in charge of the Mokelumne Division of the East Bay Municipal Utility District, gave a talk and showed a motion picture on the various phases of the Second Mokelumne Pipe Line.

Films, "Welding of Red Brass Pipe" and "High Speed Tube Welding" were shown through the courtesy of the Air Reduction Sales Co.

SOUTH TEXAS

Dinner meeting attended by members of the Board of Directors and the visiting speaker was held in the Houston Club on Sept. 15th. G. N. Sieger, President of S-M-S Corp., Detroit, was the speaker at the Technical Session. Mr. Sieger spoke on "Resistance Welding" and "Future Responsibility of the A.W.S." A film "This Is Resistance Welding" was shown through the courtesy of the General Electric Co.

All meetings of the South Texas Section will be held at the University of Houston during the coming year. Facilities of the University Vocational Training Department are being made available, and will make possible the presentation of "live" demonstrations and such technical sessions as may be arranged by the Program Committee.

The South Texas Section is cooperating with other Sections in its District to arrange for speakers on "tour," and preliminary plans have been made to conduct a welding "short course" at the University of Houston in November.

SYRACUSE

The first meeting of the season was held Wednesday evening, Sept. 10th, at the Hotel Syracuse. The meeting got under way with the showing of the film "On the Trail." After the film, the technical chairman, Mr. James Solar of the Greyhound Co. gave a very interesting short talk on the application of welding to the repair and maintenance of buses. His talk contained many practical, time-saving suggestions which were the result of many years' experience.

At the conclusion of his talk, Mr. Solar introduced the main speaker of the evening, H. S. Swan of the American Locomotive Co., who spoke on "Welding Steam and Diesel Locomotives." His talk was illustrated by a number of excellent slides showing the part welding plays in the construction of the all-welded steam locomotive boilers and also the very large part welding plays in the fabrication of the new type Diesel Streamliners. At the conclusion of Mr. Swan's talk, there was an informal discussion period over coffee and sandwiches which was enjoyed by the 96 members and guests present.

TOLEDO

The 1947–48 season of the Toledo Section started on Sept. 9th with a well-planned joint meeting between the local sections of the A.W.S. and the AIEE at the Commodore Perry Hotel.

G. W. Garman, Application Engineer with General Electric Co., Schenectady, N. Y., spoke on the subject, "Importance of Control in Resistance Welding." His subject was well delivered and well received. It was illustrated by lantern slides to bring home some points more clearly.

WESTERN MICHIGAN

The first meeting of the season of the Western Michigan Section was held on Sept. 29th at the Association of Commerce Building. Dinner was served to 40 guests and members.

The new Chairman, Everett Mattson, called the meeting to order. The new Vice-Chairman, John Borman, gave a brief talk covering plans for further meetings. Two exceedingly interesting plant visitations are to be made during the year.

The speaker of the evening was Don Corey, Welding Engineer of the Detroit Edison Co. A crowded room of 70 members and friends were highly pleased with the excellent talk Mr. Corey presented.

WESTERN NEW YORK

The 1947–48 season of this Section started off with an excellent meeting on Sept. 25th. George N. Sieger, President, S-M-S Corp., and Second Vice-President of the A.W.S., was the speaker of the evening. George presented his subject, "The Status of Resistance Welding Today," very ably and made it extremely interesting, as well as informative. The lively discussion which followed indicated the interest of the audience. A General Electric movie on Resistance Welding added further interest and color.

The meeting was well attended, with some 50 men present for the regular dinner and social gathering which preceded the meeting. A good number of guests were present, the first meeting of the year having been designated as guest night.

The November and December meetings will be combined for a visit to the new Westinghouse plant at Buffalo, on Dec. 4th. The visit will start with dinner at the plant cafeteria, followed by a tour of inspection.

WORCESTER

The Worcester Section held its September meeting on Monday evening, the 29th, at the Sanford Riley Hall, Worcester Polytechnic Institute. Carl Johnson, Associate Professor in the Department of Mechanical Engineering, Worcester Polytechnic Institute, spoke on "Weldability and Metallurgy of Welding." A movie, "Welding the Big Inch," was also shown. Prof. Johnson's talk was clear cut and highly interesting to all.

YORK-CENTRAL PA.

The Oct. 1st meeting was held in the Engineers' Club, York, Pa. Dinner in the Yorktowne Hotel preceded the meeting. Rodger J. Metzler, Dev. Engineer, Handy & Harman, presented a very practical paper on the subject, "Silver Alloy Brazing." Films on Aluminum Welding and Aluminum Brazing were shown.

CANADIAN

The Kitchener-Waterloo Chapter of the Canadian Welding Society held its first meeting of the 1947–48 series on Wednesday, Oct. 1st, at K-W Y.M.C.A. Auditorium. Stephen R. Knott, Field Engineer, Handy & Harman of Canada Limited spoke on "Silver Brazing Alloys in Industry."

The Hamilton Chapter held its first meeting of the 1947–48 series on Tuesday, Oct. 7th, at McMaster University. "New Developments in Acetylene Welding," was presented by F. G. Kerry, Manager, Development and Engineering Dept., Canadian Liquid Air Co. Ltd.

The Montreal Chapter held the first meeting of the 1947–48 season on Wednesday Oct. 8th, at the Berkeley Hotel. Gorden N. Sale, Manager, Process Service Department, Dominion Oxygen Co. Ltd. Toronto, spoke on "Heliarc Welding."

The following is the schedule of meetings for the remainder of the season of the Montreal Chapter.

Nov. 24th— "Reclamation of Tools & Dies," by F. E. Kessler, Welding Equipment & Supplies.

Dec. 22nd—Stump the Experts Night —Film: "Steel, Man's Servant."

Jan. 19th—"Electrode Design and Their Uses," by J. Humberstone, Arcrods Corp.

Feb. 16th—"Structural Steel Fabrication," by LaMotte Grover, Air Reduction Co.

Mar. 15th—"Pressure Piping," by Crane Co., Chicago.

Apr. 26th—Local Boys Night.

May 26th—"Magnaflux & Zyglo," by Magnaflux Corp.

List of New Members

September 1 to September 30, 1947

BRIDGEPORT

Ackley, Elton T. (C), General Electric Co., c/o Works Lab., 1285 Bond St., Bridgeport, Conn.

Gardner, Carroll H., Jr. (C), 179 Rivercliff Dr., Devon, Conn.

Mulligan, George Francis, Jr. (B), 165 Post Rd., Fairfield, Conn.

Reigle, John (C), General Electric Co., c/o Works Lab., 1285 Boston Ave., Bridgeport, Conn.

CANADA

Raham, M. (C), 485 Notre Dame Ave., St. Lambert, P. Q., Canada.

CHATTANOOGA

Coleman, Geo. O. (C), Coleman Bros. Welding Co., 901 Dodson Ave., Chattanooga, Tenn.

Phillips, Claude E. (C), 1201 E. 33rd St., Chattanooga, Tenn.

CHICAGO

Lyons, John M. (C), 7431 Princeton Ave., Chicago 21, Ill.

Walsh, Mark L. (C), 4126 N. Paulina Ave., Chicago 13, Ill.

CINCINNATI

Menges, R. A. (C), 2638 Harrison Ave., Cincinnati 11, Ohio.

Shepard, Kenneth Ray (C), 5624 Eula Ave., Westwood Branch, Cincinnati 11, Ohio.

CLEVELAND

Bass, Harvey G. (B), 2095 Alton Rd., East Cleveland 12, Ohio.

Bica, Michael (C), 626 Cleveland Rd., Ravenna, Ohio.

Burke, Donald J. (B), General Welding Co., 7104 Euclid Ave., Cleveland 3, Ohio.

Hillegas, James, Jr. (C), 449 Arbor Rd., Cleveland 8, Ohio.

Lucas, John J. (C), 2261 E. 14th St. Cleveland, Ohio.

Pearse, W. A., Jr. (C), 1 Interstate St., Bedford, Ohio.,

Profughi, V. A. (C), Royal Machine & Tool Co., 700 E. 163rd St., Cleveland, Ohio.

Regn, Paul M. (C), 136 W. Grace St., Bedford, Ohio.

Reichel, George F. (C), 3448 W. 152 St., Cleveland, Ohio.

Snyder, R. G. (C), R. D. 1, Box 550, Akron, Ohio.

Stevenson, Frederick H. (C), 1251 Hathaway Ave., Lakewood 7, Ohio.

Thompson, Lawrence R. (C), 1731 Eastham Ave., E. Cleveland, Ohio.

Vajda, Elemir Carl (B), Royal Machine & Tool Co., 700 East 163rd St., Cleveland 10, Ohio.

Watson John A., Jr. (C), 2588 Nesbitt Ave.; Akron 14, Ohio.

Wych, Lester F. (C), 4503 Henritze Ave., Cleveland, Ohio.

COLORADO

Anderson, Floyd R. (B), Gardner-Denver

Co., 2130 So. St. Paul St., Denver 10, Colo.
Dixon, Woodrow (C), 305 Madison St., Denver, Colo.
Gillin, Robert S. (C), 730 So. Logan St., Denver, Colo.
Jewell, Willard P. (C), 135 Garfield St., Denver, Colo.
Webster, Lewis B. (C), 3139 Umatilla St., Denver, Colo.
Wood, James C. (C), P. O. Box 866 Arvada, Colo.

DAYTON

Mc Callum, Arch F. (B), Sta. A., Box 98, Dayton, Ohio.

DETROIT

Brady, Harold R. (C), 1325 Beard St., Flint, Mich.
Buckman, Fred A. (C), 1182 Park, Lincoln Park 25, Mich.
Clayton, John R. (C), Saginaw Welding Supply Co., 311 Stoker Dr., Saginaw, Mich.
Elliott, Lauren F. (C), 502 Bangs St., Flint, Mich.
Enk, George W. (B), 12832 Wade St., Detroit 13, Mich.
Fegley, V. A. (B), Resistance Welder Corp., 116 First St., Bay City, Mich.
Heska, Lewis (C), Resistance Welder Corp., 116 First St., Bay City, Mich.
Hresko, Steve (B), Resistance Welder Corp., 116 First St., Bay City, Mich.
Kaunitz, C. F. (B), Resistance Welder Corp., 116 First St., Bay City, Mich.
Kaunitz, R. W. (C), Resistance Welder Corp., 116 First St., Bay City, Mich.
Koehler, Ralph (C), Resistance Welder Corp., 116 First St., Bay City, Mich.
Kolbe, Robert (C), Saginaw Welding Supply Co., 311 Stoker Dr., Saginaw, Mich.
Learman, Frank C. (C), 402 Shearer Bldg., Bay City, Mich.
Liley, Woodrow (C), 4221 Milton Dr., Flint, Mich.
Neumann, Richard (C), Fisher Body Corp., Plant 1, 337 Cloverdale Pl., Flint 3, Mich.
Nichols, Leonard E. (B), 6-255 General Motors Bldg., Detroit 2, Mich.
Roethlisberger, Robert (C), Saginaw Welding Supply Co., 311 Stoker Dr., Saginaw, Mich.
Rogers, Howard L. (C), 8430 Beecher Rd., Flushing, Mich.
Roth, Clifford E. (C), National Electric Welding Mach. Co., 1846–60 North Trumbull St., Bay City, Mich.
Shifrin, Edwin G. (C), The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.
Stajich, Milton (C), Naval Air Station, Grosse Ile, Mich.
Wagner, Arnold F. (C), National Electric Welding Mach. Co., Bay City, Mich.
Wagner, Milarn P. (C), Saginaw Welding Supply Co., 311 Stoker Dr., Saginaw, Mich.

KANSAS CITY

McCormick, Don E. (C), 5516 Olive, Kansas City, Mo.

LEHIGH VALLEY

Swepston, Harry D. (B), Commercial Gas Corp., P. O. Box 348, Wilkes-Barre, Pa.

LOS ANGELES

Armstrong, Les. A. (C), Superior Tank & Constr., 6155 Eastern, Los Angeles 22, Calif.
Barlow, Carl N. (C), 232 So. Union Pl., Los Angeles 26, Calif.
Bryant, Kenneth D. (C), Contour Marker Corp. of Calif., 1843½ E. Compton Blvd., Compton, Calif.
McMullen, Jack A. (C), Security Engrg. Co., Whittier, Calif.
Seedorff, Alexander P. (B), 10990 Wilshire Blvd., Los Angeles 24, Calif.

LOUISVILLE

Scott, George F. (C), 308 S. Fifth St., Louisville 2, Ky.

MAHONING VALLEY

Hardie, W. R. (B), National Cylinder Gas Corp., Box 86, Lowellville, Ohio.

MARYLAND

Bloom, F. Kenneth (B), The American Rolling Mill Co., 3400 E. Chase St., Baltimore 13, Md.
Robertson, Robert E. (B), Saxe, Williar & Robertson, 130 W. Hamilton St., Baltimore 1, Md.

MICHIANA

Lavengood, Thom H. (C), 832 28th St., So. Bend, Ind.
Robinson, Jack D. (C), 826 Diamond Ave., So. Bend, Ind.
Stolp, R. C. (C), 405 Napoleon Blvd., So. Bend Ind.

MILWAUKEE

Miller, George A. (B), G. A. Miller Co., 110 E. Wisconsin Ave., Milwaukee 2, Wis.

NEW JERSEY

Witting, Carl Richard (C), 149 Fern Ave., Lyndhurst, N. J.

NEW YORK

Chevalier, Henry B. (B) c/o Mr. Saccard A.C.E.C., N. Y. Office, 1 East 53rd St., New York 22, N. Y.
Gumenik, Hyman (C), The Dentor & Anderson Co., 1239 Chrysler Bldg. New York 17, N. Y.
Lucas Wilford E. G. (B), 205-24 116th Ave., St. Albans 11, N. Y.
McCallian Richard (C), 215 W. 23rd St., New York 11, N. Y.
Michne, Joseph (B), New York Central System, 466 Lexington Ave., New York 17, N. Y.

NORTHERN N. Y.

Curran, Robert M. (D), 141 Saratoga St., Cohoes, N. Y.
Domina, Frederick H. (D), 207 Hoosick St., Troy, N. Y.
Minkler, Ward W. (D), Theta X. I., Saga Ave., Troy, N. Y.
Patriarca, Peter (D), 9-2 Edgehill Terrace, Rensselaerwyck, Troy, N. Y.

NORTHWEST

Burns, James T. (B), 3400 Valley View Dr., Minneapolis 12, Minn.
Fox, D. E. (C), Fox Bros., Inc., 722 No. Concord St., So. St. Paul, Minn.
Hartz, Clarence J. (C), 6701 4th Ave., So., Minneapolis 9, Minn.
Peterson, E. A. (C), Harnischfeger Corp., 840 Lumber Exchange Bldg., Minneapolis 1, Minn.
Porter, Arthur T. (C), 5117 Indianola Ave., Minneapolis, Minn.
Schardin, Arther B. (C), 1849 Park Pl., Minneapolis, Minn.
Solheim, Sherwin L. (C), 840 Lumber Exchange Bldg., Minneapolis, Minn.
Stanley, A. L. (C), 840 Lumber Exchange, Minneapolis 1, Minn.

NORTHWESTERN, PA.

Odell, George N. (B), Struthers-Wells Corp., Warren, Pa.

OKLAHOMA CITY

Conine, McNeill (C), Box 2457, Stockyards Sta., Oklahoma City 8, Okla.
Gregg, Otto C. (C), Rt. 4, Box 44, Oklahoma City 4, Okla.
Jackson, R. O. (C), Oklahoma Gas & Electric Co., Harrah, Okla.
Reeves, Elbert B. (C), 1101 Lombardy Rd., Oklahoma City, Okla.
Stotts, Troy S. (C), 1416 N. W. 9th, Oklahoma City 9, Okla.

PASCAGOULA

Aikens, J. W. (C), 1002 Buena Vista St., Pascagoula, Miss.

PHILADELPHIA

Bauder, George H. (C), 2017 E. Hazzard St., Philadelphia 25, Pa.
Renz, Avery N. (C), 63 Ave. D., Claymont, Del.

PITTSBURGH

Anderegg, Henry P. (B), 1740 Main St., Sharpsburg, Pittsburgh 15, Pa.
Duchene, Richard P. (B), Leonard R. Nourie, 1229 Park Bldg., Pittsburgh, Pa.
Laughner, E. M. (B), R. D. 2, Jeannette, Pa.
Lautner, W. K. (B), Westinghouse Elec. Corp., 6744 Penn Ave., Pittsburgh 8, Pa.
Perry, George W. (B), Leonard R. Nourie, Inc., 1229 Park Bldg., Pittsburgh, Pa.
Saur, Gail E. (B), 1009 Kirkpatrick St., North Braddock, Pa.

PORTLAND

Hillman, H. L. (C), National Cylinder Gas Co., 2720 N. W. Yeon Ave., Portland, Ore.

PUGET SOUND

Bakke, Elmer (C), 401 Pontius, Seattle, Wash.
Longley, Wm. I. (C), Eagle Metal Co., 3628 E. Marginal Way, Seattle 4, Wash.
Maple, E. H. (C), 7924 Lakeridge Dr., Seattle 88, Wash.
McBride, G. Morgan, Jr. (C), 2949 16th S. W., Seattle, Wash.

ROCHESTER

Statucki, Walt (C), Distillation Prods., Inc., 755 Ridge Rd. W., Rochester 13, N. Y.

ST. LOUIS

Grob, Harold O. (C), 6145 N. Pointe Blvd., St. Louis 21, Mo.

Juergens, W. A. (B), Machinery & Welder Corp., 700 S. Spring, St. Louis, Mo.
McDonald, Harold E. (C), Harris Calorific sales Co., 3618 North Broadway, St. Louis, Mo.

SAN FRANCISCO

Kelly, Foster James (C), Chicago Bridge & Iron Co., Rm. 908, 22 Battery St., San Francisco, Calif.

SOUTH TEXAS

Steward, Jack (C), Univ. of Houston, School of Technology, Houston, Tex.

SYRACUSE

Arnold, Lew (C), Hotel Syracuse, Syracuse, N. Y.
Bennett, Porter K. (B), Champion Sheet Metal Co., 1 Squires St., Cortland, N. Y.
Burke, Charles E. (C), 2283 Milton Ave., Solvay, N. Y.
Oakes, Leon H. (B), Box 525, New Hartford, N. Y.
Thornton, Robert V. (C), 135 Mosley Dr., Syracuse, N. Y.

TOLEDO

Farnsworth, V. L. (B), Farnsworth & Middlekauff, Inc., 1535 Ketcham Ave., Toledo 8, Ohio.
Judson, Richard C. (B), The Acklin Stamping Co., 1925 Nebraska Ave., Toledo 7, Ohio.

WESTERN MICHIGAN

Bosworth, Lyle F. (B), Mulliken, Mich.

WESTERN N. Y.

Gehring, R. P. (C), Box 2025, Buffalo, N. Y.
Webb, Watt W. (C), 4625 Royal Ave., Niagara Falls, N. Y.

YORK-CENTRAL PA.

Benedict, Donald (B), A. B. Farquhar Co., York, Pa.
Kugle, John (B), A. B. Farquhar Co., York, Pa.
Luckenbaugh, Robert (B), A. B. Farquhar Co., York, Pa.
Rickrode, P. A. (B), A. B. Farquhar Co., York, Pa.

NOT IN SECTIONS

Brown, William Bolton (C), Hooghly Docking & Engrg. Co., Ltd., P. O. Box 21 Howrah Bengal, India.
Ingwall, Carl T. (B), Sandgatan 12A, Norrkoping, Sweden.
Jones, E. (C), 32 Richmond St., Totterdown, Bristol, England.
Jones, S. O. (A), Newport News Shipbldg. & D.D. Co., Newport News, Va.
Landrum, R. J. (B), 108 Porter Rd., Oak Ridge, Tenn.
Lang, Florian G. (C), The Sao Paulo Tramway Light & Power Co., Lts., Caixa Postal 26-B, Sao Paulo, Brazil.
Lovelady, I. W. (C), Sivalls Tanks, Inc., 2200 E. Second St., P. O. Box 2627, Odessa, Texas.
Luthy, Adolph (A), Brown Boveri & Co., Ltd., Baden, Switzerland.

Members Reclassified

During Month of September

CHICAGO

Michaels, E. E. (B to A), Chicago Bridge & Iron Co., 1305 W. 105th St., Chicago 43, Ill.
Porter, Delbert D. (C to B), Electro-Motor Div. of Gen Motors, c/o Locomotive Inspection office, 55th & La Grange Rd., La Grange, Ill.

DETROIT

Ballard, Edward A. (C to B), Taylor & Gaskin, Inc., 3105 Beaufait Ave., Detroit, Mich.

MILWAUKEE

Alexandroff, Paul (C to B), Bentley Sales Co., 645 S. 28th St., Milwaukee Wis.

NEW JERSEY

Babcock, R. S. (C to B), The Linde Air Products Co., 646 Frelinghuysen Ave., Newark, N. J.

NEW YORK

Wilson, Robt. E. (C to B), Air Reduction Sales Co., Rm. 1132., 60 E. 42nd St., New York 17, N. Y.

SOUTH TEXAS

Smith, E. A. (C to B), Magnolia Airco Products Co., Laurel & Centre Sts., Beaumont, Tex.

YORK-CENTRAL PA.

Allen, Charles W. (C to B), 221 S. Albemarle St., York, Pa.
Seitz, Leo B. (C to B), 301 Garden Lane, Hillcroft, York, Pa.

SECTIONS—CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

1—NEW YORK AND NEW ENGLAND

District Vice-President:
GEORGE M. TREFTS, Farrar & Trefts, Inc., 20 Milburn St., Buffalo, N. Y.

BOSTON — 1st Mon.
CHAIRMAN—HERBERT G. AUSTIN, Lukenweld, Inc., 131 State St., Boston 9, Mass.
SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

BRIDGEPORT — 3rd Thurs.
CHAIRMAN—JOSEPH R. SKIBO, Laurel Pl., Derby, Conn.
SECRETARY—M. P. BENNETT, 97 Rosewood Pl., Bridgeport 4, Conn.

HARTFORD — 3rd Thurs.
CHAIRMAN—RICHARD H. FLORIAN, Trumbull Elec. Mfg. Co., Plainville, Conn.
SECRETARY—D. E. WERTS, 320 Church St., Hartford, Conn.

NEW JERSEY — 3rd Tues.
CHAIRMAN—R. T. PURSELL, L. O. Koven & Bros. Co., Dover, N. J.
SECRETARY—P. M. MATTERN, c/o Wislon Welder & Metals, 60 East 42nd St., New York 17, N. Y.

NEW YORK — 2nd Wed.
CHAIRMAN—H. R. MORRISON, 229 West Ave., Darien, Conn.
SECRETARY—L. P. GRANGER, The Linde Air Prods. Co., 30 East 42nd St., New York 17, N. Y.

NORTHERN NEW YORK — Last Thurs.
CHAIRMAN—EDMUND N. BOSWELL, 1087 Regent St., Schenectady 8, N. Y.
SECRETARY—A. G. CRAIG, General Electric Co., Building 28, 1 River Rd., Schenectady, N. Y.

ROCHESTER — 1st Thurs.
CHAIRMAN—EDWARD JONES, 825 Commerce Bldg., Rochester, N. Y.
SECRETARY—WALTER G. DICK, 474 Stonewood, Rochester 12, N. Y.

SYRACUSE — 2nd Wed.
CHAIRMAN—J. T. HOTCHKISS, Highbridge St., Fayetteville, N. Y.
SECRETARY—E. LARRY SMITH, Fayetteville Rd., Manlius, N. Y.

WESTERN MASSACHUSETTS — 2nd Tues.
CHAIRMAN—SIDNEY LOW, 144 Buckingham St., Springfield, Mass.
SECRETARY—ALBERT LABOSSIERE, 57 Martha St., Indian Orchard, Mass.

WESTERN NEW YORK — Last Thurs.
CHAIRMAN—CLARENCE E. JACKSON, Union Carbide & Carbon Res. Labs., 4625 Royal Ave., Niagara Falls, N. Y.
SECRETARY—RICHARD HOAGLUND, Westinghouse Electric Corp., Box 2025, Buffalo, N. Y.

WORCESTER — 1st Tues.
CHAIRMAN—JOHN F. SLOAN, Supt., Haynes Welding Co., 1 Coes Square, Worcester, Mass.
SECRETARY—ROBERT JAMIESON, Gaychrome Co., 25 St. Johns Rd., Worcester, Mass.

2—MIDDLE EASTERN

District Vice-President:
HARRY W. PIERCE, New York Shipbuilding Corp., Camden, N. J.

LEHIGH VALLEY — 1st Mon.
CHAIRMAN—GILBERT E. DOAN, Lehigh University, Dept. of Metallurgical Engrg., Bethlehem, Pa.
SECRETARY—JULIUS NAAB, Ingersoll Rand Co., Phillipsburg, N. J.

MARYLAND — 3rd Fri.
CHAIRMAN—A. C. EARLBECK, T. A. CANTY, Inc., 1023 Cathedral St., Baltimore 1, Md.
SECRETARY—G. E. LINNERT, Rustless Iron & Steel Div., American Rolling Mill Co., Research Labs., 3400 E. Chase St., Baltimore 13, Md.

PHILADELPHIA — 3rd Mon.
CHAIRMAN—E. R. MCCLUNG, JR., Lukenweld, Inc., Coatesville, Pa.
SECRETARY—K. WM. OSTROM, 1525 Wood St., Philadelphia 2, Pa.

WASHINGTON, D. C. — Last Tues.
CHAIRMAN—R. P. MCMILLAN, Southern Oxygen Co., P. O. Box 5087, Washington, D. C.
SECRETARY—E. M. MACCUTCHEON, Secretary, American Welding Society, Washington Section, U. S. Coast Guard, Washington 25, D. C.

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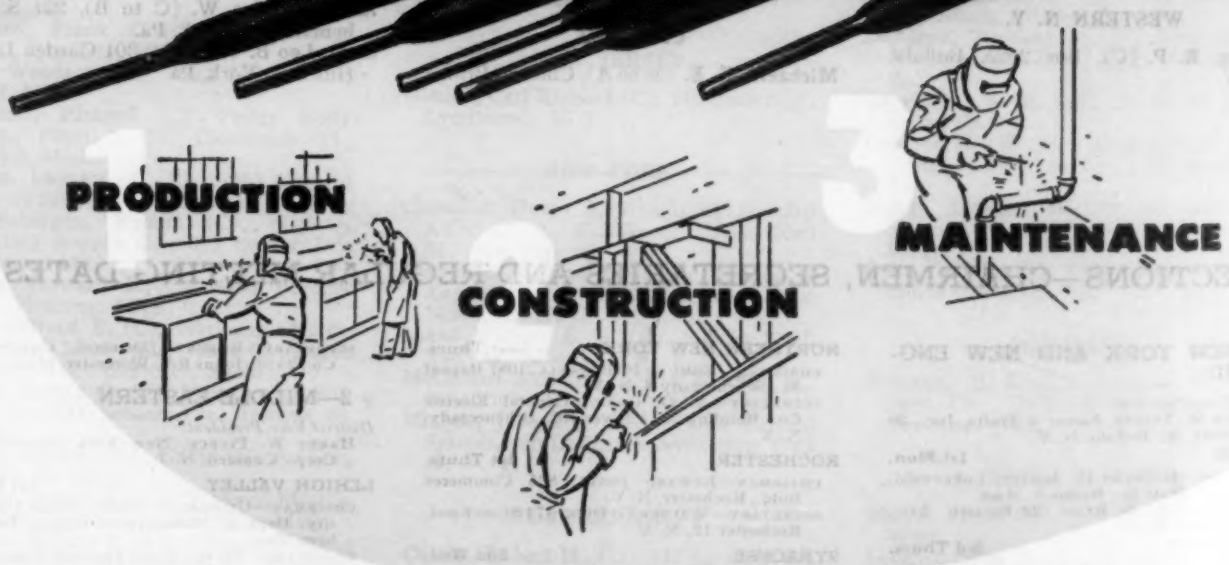

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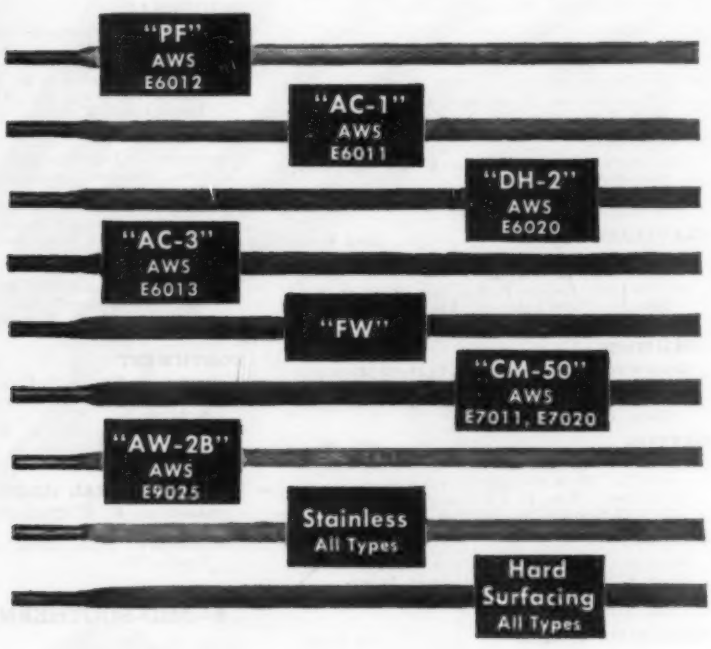

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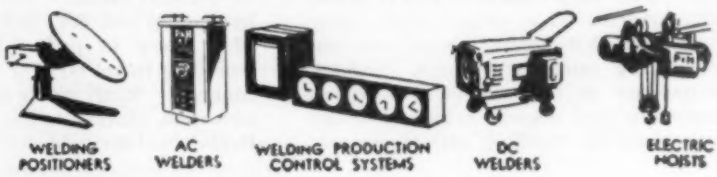

YORK-CENTRAL PA. — **1st Wed.**
CHAIRMAN—William B. Hess, Safe Harbor Water Power Corp., R. D. 2, Conestoga, Pa.
SECRETARY—G. A. Ostrom, Abbottstown, R. D. 1, Pa.

3—SOUTHERN

District Vice-President:
R. E. Lorentz, Jr., Combustion Engineering Co., Inc., 1032 West Main St., Chattanooga 1, Tenn.

ATLANTA
SECRETARY—J. V. Turner, Air Reduction Sales Co., 186 Williams St., N. W., Atlanta, Ga.

BIRMINGHAM — **1st Thurs.**
CHAIRMAN—W. B. Browning, The Linde Air Prods. Co., 1001-13 S. 22nd St., Birmingham 1, Ala.
SECRETARY—W. L. Poole, P. O. Box 2583, Birmingham, Ala.

CHATTANOOGA — **1st Thurs.**
CHAIRMAN—R. E. Brooks, Combustion Engrg. Co., 1032 W. Main St., Chattanooga 1, Tenn.
SECRETARY—R. W. Baker, Welding Gas Prods. Co., 821 E. 11th St., Chattanooga, Tenn.

NEW ORLEANS — **1st Fri.**
CHAIRMAN—J. F. Houppert, P. O. Box 116, Harvey, La.
SECRETARY—Donald M. Sarrat, Gulf Welding Equip. Co., 1133 Magazine St., New Orleans 13, La.

PASCAGOULA — **1st Wed.**
CHAIRMAN—J. A. Furr, Briggs Beach Bungalows, Pascagoula, Miss.
SECRETARY—Thos. J. Dawson, Ingalls Shipbuilding Corp., Pascagoula, Miss.

4—CENTRAL

District Vice-President:
G. O. Hoglund, Aluminum Co. of America, New Kensington, Pa.

CINCINNATI — **Last Tues.**
CHAIRMAN—Wm. F. Pahner, R. R. 1, Box 45A, Sharonville, Ohio.
SECRETARY—Robt. F. Martin, 3866 Kilbourge, Cincinnati 9, Ohio.

CLEVELAND — **2nd Wed.**
CHAIRMAN—Michael Shane, 9304 Amesbury St., Cleveland 6, Ohio.
SECRETARY—Joseph F. Wagner, Burdett Oxygen Co., 3300 Lakeside Ave., Cleveland 14, Ohio.

COLUMBUS — **2nd Fri.**
CHAIRMAN—C. B. Voldrich, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio
SECRETARY—G. S. Herren, The Seagrave Corp., Columbus, Ohio.

DAYTON — **4th Wed.**
CHAIRMAN—Carl F. Smith, Sight Feed Generator Co., West Alexandria, Ohio.
SECRETARY—Wm. P. Taylor, W. H. Kiefaber Co., 40 Keowee St., Dayton, Ohio.

DETROIT — **2nd Fri.**
CHAIRMAN—A. J. Last, Welding Sales & Engrg. Co., 8750 Grinnell Ave., Detroit, Mich.
SECRETARY—K. B. Brown, American Brass Co., Detroit 31, Mich.

MAHONING VALLEY — **2nd Tues.**
CHAIRMAN—Wilson Scott, Westinghouse Elec. Corp., Sharon, Pa.
SECRETARY—Joseph J. Riley, 672 Perkins Dr., Warren, Ohio.

NORTHWESTERN, PA — **Last week of month**
CHAIRMAN—W. H. Cochran, General Electric Co., Fast Lake Rd., Erie, Pa.
SECRETARY—W. R. Boyd, Boyd Welding Co., 160 E. 8th St., Erie, Pa.

PITTSBURGH — **3rd Wed.**
CHAIRMAN—H. P. Schane, Mellon Institute of Industrial Research, Pittsburgh, Pa.
SECRETARY—J. F. Minnotte, Minnotte Bros. Co., Hays 7, Pittsburgh, Pa.

TOLEDO — **2nd Tues.**
CHAIRMAN—E. V. Newman, 4021 Bowen Rd., Toledo, Ohio.
SECRETARY—Edwin Nafzger, Toledo Steel Tube Co., 2105 Smead Ave., Toledo 6, Ohio.

WESTERN MICHIGAN — **Last Mon.**
CHAIRMAN—Everett Mattson, 3436 Coit Rd. N.E., Grand Rapids, Mich.
SECRETARY—Ivan R. Bartter, Lincoln Electric Co., 706 Jefferson, S.E., Grand Rapids, Mich.

5—MID-WESTERN

District Vice-President:
J. R. Wirt, Delco Remy Div., General Motors Corp., Anderson, Ind.

CHICAGO — **3rd Fri.**
CHAIRMAN—Chas. O. Druetzler, Electro-Motive Div., General Motors Corp., La-Grange, Ill.
SECRETARY—T. B. Jefferson, The Welding Engineer, 520 N. Michigan, Chicago, Ill.

INDIANA — **Last Fri.**
CHAIRMAN—James R. Neff, 2630 Ryan Dr., Indianapolis, Ind.
SECRETARY—Mrs. Mercedes Spotts, P. R. Mallory & Co., Indianapolis, Ind.

LOUISVILLE — **4th Wed.**
CHAIRMAN—Edmund F. Schulz, Louisville & Nashville R.R. Co., So. Louisville Ships, Louisville, Ky.
SECRETARY—Arthur B. Doudna, Louisville Gas & Electric Corp., 311 W. Chestnut St., Louisville 2, Ky.

MICHIANA — **3rd Fri.**
CHAIRMAN—John Grodrian, Bendix Products Div., Bendix Aviation Corp., 401 Bendix Dr., South Bend, Ind.
SECRETARY—M. G. Fassnacht, Bendix Products Div., Bendix Aviation Corp., 401 Bendix Dr., South Bend, Ind.

MILWAUKEE — **4th Fri.**
CHAIRMAN—Harold E. Bailie, 2304 E. Ohio Ave., Milwaukee 7, Wis.
SECRETARY—R. P. Walbridge, 3853 N. 53rd St., Milwaukee, Wis.

NORTHWEST — **1st week of month**
CHAIRMAN—Edgar E. Hall, Flour City Welding Co., 2937 Third Ave., So., Minneapolis 8, Minn.
SECRETARY—Lillian K. Polzin, Minneapolis Chamber of Commerce, 100 Pillsbury Bldg., Minneapolis 2, Minn.

PEORIA-CENTRAL ILLINOIS — **3rd Wed.**
CHAIRMAN—K. H. Jackson, 307 Jefferson St., Washington, Ill.
SECRETARY—Lyle Bibb, 406 E. Armstrong, Peoria, Ill.

6—MID-SOUTHERN

District Vice-President:
Howard N. Simms, 1217 S.W. 32, Oklahoma City, Okla.

COLORADO — **2nd Tues.**
CHAIRMAN—H. Jackson, Thompson Pipe & Steel Co., Larimer & 30th St., Denver, Colo.
SECRETARY—C. Brinton Swift, The Linde Air Prods. Co., 2101 Blake St., Denver 2, Colo.

KANSAS CITY — **1st Mon.**
CHAIRMAN—William J. Snider, 4105 E. 37th St., Kansas City 3, Mo.
SECRETARY—Wilbur F. Wheeler, National Cylinder Gas Co., 1814 Oak St., Kansas City, Mo.

OKLAHOMA CITY — **1st Thurs.**
CHAIRMAN—Denver House, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.
SECRETARY—R. J. Trautman, Air Reduction Sales Co., P. O. Box 2457, Stockyards Sta., Oklahoma City, Okla.

ST. LOUIS — **2nd Fri.**
CHAIRMAN—Gayden Derickson, c/o Shell Oil Co., Inc., Wood River, Ill.
SECRETARY—A. Pandjiris, Pandjiris Weldment Co., 5151 Northry Ave., St. Louis 10, Mo.

SOUTH TEXAS — **3rd Fri.**
CHAIRMAN—Steven R. Demecs, Westinghouse Elec. Corp., 612 Petroleum Bldg., Houston, Tex.
SECRETARY—W. H. Greer, Southwestern Labs., P. O. Box 175, Houston 1, Tex.

TULSA
CHAIRMAN—Frank O. Johnson, 322 West Easton, Tulsa 6, Okla.
SECRETARY—J. B. Davis, Tulsa Testing Labs., Box 2654, Tulsa, Okla.

WICHITA — **2nd Mon.**
CHAIRMAN—J. T. Phillips, 301 Old Manor Rd., Wichita 8, Kan.
SECRETARY—Robert F. Dick, Kansas Gas & Elec. Co., 201 N. Market, Wichita, Kan.

7—WESTERN

District Vice-President:
Prof. Gilbert S. Schaller, University of Washington, Seattle, Wash.

HAWAII
CHAIRMAN—Howard J. Shanley, 514 Tenth St., Naval Housing, Honolulu 50, T. H.
SECRETARY—Alan G. Slipper, Hawaiian Gas Prods. Co., P. O. Box 2454, Honolulu, T. H.

INLAND EMPIRE — **Last Tues.**
CHAIRMAN—Evgene B. LaVelle, Box 96, Coeur D'Alene, Idaho.
SECRETARY—Glenn Wilson, J. E. Haseltine, N. 1101 Division St., Spokane, Wash.

LONG BEACH
CHAIRMAN—V. M. Goode, 262 Covina Ave., Long Beach, Calif.
SECRETARY—George Duncan, 1501 Branco Ct. Channel Hgts., San Pedro, Calif.

LOS ANGELES — **3rd Thurs.**
CHAIRMAN—A. L. Fenalson, 834 Arno Lane, El Monte, Calif.
SECRETARY—Charles Johnston, 6423 Sherman Way, Bell, Calif.

PORTLAND — **3rd Tues.**
CHAIRMAN—Paul Kullberg, Industrial Specialties Co., 940 S.E. 7th Ave., Portland, Ore.
SECRETARY—J. H. Crumley, c/o King Bros., 3500 S.E. 17th St., Portland, Ore.

PUGET SOUND — **3rd Wed.**
CHAIRMAN—Myron D. Stepath, Route 2, Box 977, Bremerton, Wash.
SECRETARY—Stanton Richardson, Air Reduction Sales Co., 3263 E. Marginal Way, Seattle, Wash.

SAN FRANCISCO — **4th Mon.**
CHAIRMAN—L. P. Henderson, Lincoln Electric Co., 1303 Stanford Ave., Emeryville, Calif.
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ANNUAL REPORT

on ACTIVITIES of the AMERICAN WELDING SOCIETY

YEAR ENDED SEPTEMBER 30, 1947

PRESIDENT'S ADDRESS TO THE MEMBERS OF THE AMERICAN WELDING SOCIETY

By L. W. Delhi

IN JOURNEYING to Chicago to attend this Annual Meeting of the American Welding Society we have reached another milestone in the history of a worthy and highly integrated technical society. A milestone marked by a continually expanding participation with the A.S.M. in an educational endeavor, and an interesting industrial exhibit of the most modern equipment, tools and materials, a study of which will permit all members of the American Welding Society to keep abreast of recent developments in the field of their chosen professions.

This milestone marks another year when our membership has gathered to review the accomplishments of the 12 months past; to meet and confer with their friends and associates; to hear and study the stories unfolded in the many fine technical papers upon which our brother engineers have labored so long and studiously; and to elect new officers, appoint new committees and their chairmen who will guide our affairs for the coming year, and, more particularly, to consider new policies and initiate such actions as may be required to insure a continued increase in the responsibilities and interest in the affairs of our Society.

You must be very proud of what you are seeing and hearing here this week. The materials, machines and working tools exhibited are without doubt the most modern and efficient that engineering genius and industrial knowhow can produce.

The technical discussions afford each individual member the opportunity of analyzing and discussing the greatest number of well-developed papers on basic research, engineering design, procedures and practical application of new knowledges that it has ever been our pleasure to examine.

We can with much satisfaction state that our past presidents, past and present directors, our committees and their chairmen, our most excellent staff and many, many individuals from Coast to Coast have labored diligently and intelligently, so now to all of them we can say thanks—and well done.

The past 12 months have seen our energies very largely directed toward the strengthening of our staff at headquarters.

For several years it has been evident that the two loyal, efficient and hard-working individuals, M. M. Kelly, our Secretary, and William Spraragen, Editor of the Journal and Director of the Welding Research Council, needed assistance, and of the highest order, if they were to carry out the manifold duties and fulfill the requirements of postwar adjustments necessary to the growth of our Society.

They have striven mightily, with the counsel of our directors and chairmen of the board, to execute the many directives and administer the detailed responsibilities involved in the work at headquarters. It has been difficult.

After much study on the part of a special committee and consummating several years of deep consideration, the committee, supported by the Board of Directors and your officers, provided the necessary authority and action which resulted in the addition to our staff at headquarters of a qualified administrator with the title of Executive Secretary.

This modification of our organization has met with much favorable reaction and our staff at headquarters can now expand to more adequately serve your needs and provide that additional service along avenues that have heretofore been somewhat undeveloped through lack of adequate personnel.

J. G. Magrath, our Executive Secretary since Sept. 2, 1947, joins our Society with deep appreciation of your full cooperation as fellow members for the coming year under the guidance of your new president.

It has been a great honor to have served you this year as President and I now wish to say to my predecessor, Dr. W. F. Hess, and to my successor, H. O. Hill, that your kind counsel and timely advice have been of invaluable aid this past year.

To the staff and to my many friends who have rendered yeoman support I say thanks.

And thank you all.

SUMMARY OF ACTIVITIES OF THE AMERICAN WELDING SOCIETY

For Administrative Year Ended Sept. 30, 1947

By M. M. Kelly, *Secretary*

It is gratifying to report to you that the Society closes the present administrative year showing improvement in its finances and an upward trend in its membership growth, in spite of the great loss of membership at the halfway mark of the fiscal year, occasioned by unemployment during the transition period from war to peace. It now appears many have re-established themselves and are eager for welding knowledge. This, we hope, is indicative of a more stable and stronger membership.

Our research, standardization, publications, meetings and other activities in behalf of the membership, have continued at an accelerated pace, as you will see from reports that follow. The third edition of the *Welding Handbook* is well under way and expectation is that it will be ready for distribution the latter part of 1948.

With the event of the new Executive Secretary, it is anticipated that the Sections of the Society will be serviced to a much greater extent than was possible in the past with a limited staff, the membership of the Society will be materially increased and the Society, as a whole, will profit from the vast experience of J. G. Magrath, who is already well known to many in the welding industry.

Meetings of Board of Directors and Executive Committee

During the past year, six meetings of the Board of Directors, and two meetings of the Executive Committee, of the Society were held. The practice of holding Board meetings outside of headquarters' city, excepting that held at the time of the Annual Meeting of the Society, was instituted. Board meetings were held in Detroit in February, and in Chicago in May, both to coincide with meetings of the Sections, thus providing an excellent opportunity for the Section membership to meet the National Officers and Directors. Attempt was made to arrange for a meeting during the Pacific Coast District Meeting, but distance made it impossible to obtain a quorum attendance. Other meetings of the Board, and the two Executive Committee meetings, were held in New York.

These meetings were devoted primarily to routine matters, such as, appointment of officers and commitees, establishment of policies, receiving and acting on reports of standing and special committees and the like. For purpose of clarification, three By-Law amendments were ap-

proved, one, having to do with personnel of the Nominating Committee, two, voting on Honorary Membership nominees and three, relating to requirements of an active Section. These changes are more clearly defined in report of Committee on Constitution and By-Laws.

Considerable attention was given to matters pertaining to expansion of the organization of the SOCIETY to provide for the office of Executive Secretary; the undertaking of a welding exposition sponsored by A.W.S.; Annual Meeting arrangements; enlargement of the Technical Department to include publication of the *Welding Handbook* and other educational books; finances; WELDING JOURNAL; educational activities; and membership and Section activities.

The findings of the Special Committee on Organization of the SOCIETY resulted in the appointment of J. G. Magrath to the post of Executive Secretary, as of Sept. 2, 1947. The Special Committee has been given the assignment of studying needed changes in By-Laws to legalize this appointment.

With the approval of the Committees on Technical Activities and the *Welding Handbook*, the publication of the *Welding Handbook* was assigned to the Technical Department. Due to resignation of L. M. Dalcher, Technical Secretary, as of June 1, 1947, S. A. Greenberg, Assistant Technical Secretary and Associate Handbook Editor, was advanced to the post of Technical Secretary and Editor of the *Welding Handbook*. The new Technical Secretary was empowered to seek a technical assistant.

The Board has authorized the appointment of a Special Exposition Committee with scope not yet determined, excepting the furtherance of study of advantages of sponsoring a welding exposition and for consultation with the management of the National Metal Exposition in regard to effecting a more equitable arrangement than at present, for continuance of participation in the National Metal Exposition.

During the year, a contribution of $200 was authorized by the Board toward the upkeep of the Engineering Societies Library, which is used as a reference library by the SOCIETY. Also, the Board endorsed request of W.R.C. to Engineering Foundation for support of research program in the amount of $3000.

The Board expressed its sincere appreciation of the excellent work that is being done by W.R.C. for the advancement of welding. In order to better acquaint the Board and A.W.S. membership with the historical background, reasons for separate organization on research, W.R.C. means of support and the relationship of W.R.C. to A.W.S., the Director of W.R.C. was requested to prepare a brief, concise statement for wide distribution among A.W.S. members and Directors.

The Treasurer was requested to arrange for the engagement of general counsel on a retainer, or other, basis.

The Board advocated that measures be taken to protect welding against adverse legislation in respect to National Board of Fire Underwriters' Ruling, governing the use of welding in the installation of sprinkler systems.

Further, the Board endorsed revision of rules governing R.W.M.A. Prize Contest; the Awards Committee's selection of the 1948 Adams Lecturer (Dr. G. E. Claussen); and the 1946 Samuel Wylie Miller Memorial Medallist (Dr. A. B. Kinzel).

The Board requested the Chairman of the Special Committee on Membership Requirements, in cooperation with the Chairmen of the Finance and Membership Committees, to make a thorough study of membership classification, requirements and incentives for membership. It is expected that the findings of this group will be presented shortly.

Visitation of Sections

In addition to visits received from District Vice-Presidents, reported elsewhere in this summary, some of the Sections were fortunate in having the President attend their Section meetings. President Delhi's visits included the Seattle, Portland, San Francisco, Los Angeles, Long Beach, Detroit, Flint, Cleveland, Chicago and Denver Sections. It was the Secretary's pleasure to attend meetings of the Detroit, Flint, Washington and Chicago Sections. Mr. Dalcher, Technical Secretary, made three circuits of the Sections, talking on Technical Activities of the SOCIETY. In the spring of 1946, he covered the Cincinnati, Louisville and Chattanooga Sections; in the fall of 1946, the South Texas, Pascagoula and New Orleans Sections; and the spring of 1947, the Spokane, Seattle, Wichita, Portland, Ore., Oklahoma City, San Francisco and Birmingham Sections.

Finances—(O. B. J. Fraser, Chairman)

The financial status of the SOCIETY at the end of the eleventh month of its fiscal year, presents a much more satisfactory picture than was forecast at the opening of the year. It compares quite favorably with the preceding year.

The Income and Expense figures also present a satisfactory showing considering the unsettled conditions of the year, which affected our SOCIETY as they did all other similar organizations.

At the time the budget was prepared the SOCIETY membership was at about its lowest point for the postwar period, and at the same time, practically every item of operating cost was on the increase. The Finance Committee and the Auditor saw in these signs the possibility of an operating deficit for the fiscal year ending Sept. 30, 1947. Fortunately, the outlook has changed, and in large part due to measures taken by and the wholehearted cooperation of the headquarters staff, the Publication Committee, the Membership Committee and the Technical Activities Committee. Another source of considerable help was a much larger yield from the National Metal Exposition, in connection with the SOCIETY's Annual Meeting in 1947.

The decline in membership was reversed and has been on the upgrade for the past 5 months, which has meant an increased yield of dues. The rising cost of publication of THE WELDING JOURNAL, which was threatening to eliminate the comfortable credit balances of previous years, was more than offset by increased income from advertising, due largely to an increase in advertising rates which are now more in line with the position THE WELDING JOURNAL occupies in the publishing field. Economies in production of the JOURNAL have been worked out. Careful operation of the other functions of the SOCIETY also has resulted in savings that have been of no small importance. Among these has been a lower cost of producing agenda and minutes of meetings, and other duplicated matter, which has been accomplished by purchasing a modern duplicating machine.

The Annual Meeting cost was largely offset by the return from the National Metal Exposition.

The Permanent Reserve Fund was increased during the year by the amount of accrued interest on the U. S. Treasury Bonds and on the Savings Bank cash balances of which it consists, and also by the mandatory 1% of gross income.

During the year, the Permanent Reserve Fund invested $15,000, par value, in U. S. Treasury 2½% Bonds. A more complete report on the financial operations of the SOCIETY will be published in the Annual Year Book.

The Finance Committee held four meetings during the year. Matters dealt with were the SOCIETY's annual budget, the Annual Meeting budget for 1947, salary recommendations, purchase of office equipment, consideration of ways and means of increasing revenues and decreasing expenses, and matters of policy.

The Treasurer met once with the Publication Committee for discussion of ways and means of assuring maximum net revenue from publications as a result of either increasing advertising revenues or decreasing cost of publication or both.

The Special Committee appointed to build up the Permanent Reserve Funds met once. It was decided that times were no better for reopening its activities than in the previous year, and that the Chairman of the Committee should recommend to the Board of Directors that the Committee be discharged.

Publication (A. G. Oehler, Chairman)

The Publication Committee has held two meetings during the year. For the most part, these meetings were devoted to matters of finance. The decrease between income and outgo has led the Finance Committee of A.W.S. to press heavily on the Publication Committee to increase the differential between these two items with respect to THE WELDING JOURNAL, although the JOURNAL continues, as it has throughout most of its history, to operate in the black. The income from advertising receipts reached an all-time high during the fiscal year ending Sept. 30th, but so did the cost of publication. One of the suggestions, which was not acted upon favorably was the separation of the Welding Research Supplement from the JOURNAL and the distribution of the Supplement to

only those members who desire to pay an extra sum of the order of four or five dollars per year. Eventually, this step may be necessary, but the Publication Committee felt that it should not be taken at this time.

In order to cut down the cost of publication, a special leaflet was prepared for the benefit of prospective authors stressing the desirability of brevity in the preparation of articles. This leaflet has received considerable acclaim and will, undoubtedly, be reproduced in the next issue of the Year Book.

A number of important matters of policy were satisfactorily settled by correspondence. In this respect the Publication Committee acts as an advisory group to the Editor.

The total number of pages for the Journal published for the fiscal year ending Sept. 30th are 1188 and the total number of pages in the Supplement are 816. This brings the grand total to 2004 (an all-time record).

Welding Handbook (H. C. Boardman, Chairman)

The Handbook Committee met in New York on Feb. 13, Apr. 24 and June 23, 1947.

In February 1947, following H. O. Klinke's resignation as Editor, L. M. Dalcher and S. A. Greenberg were appointed Editor and Associate Editor, respectively. In June 1947, following Mr. Dalcher's resignation, Mr. Greenberg was made Editor.

In spite of these changes of editorship, there has been sufficient progress to justify the following schedule of deadlines which was set by the Committee at its meeting on June 23, 1947: Completion of Chapter Outlines—Sept. 1, 1947; Completion of Chapter Texts—Jan. 1, 1948; Issuance of Handbook—Oct. 1, 1948.

The supply of 1942 Handbooks has run out and the Committee recommended a third printing, to meet the demand for the book during the interim period between now and July 1948, when promotion of sales on the 1948 edition will commence.

Largely due to Messrs. Dalcher and Greenberg, the new Handbook is designed to group the Chapters on processes in accordance with the Master Chart of Welding Processes prepared by the A.W.S. Committee on Definitions and Chart.

To effect uniformity of text arrangement in similar chapters, three basic outlines were prepared, one each on processes, materials and applications. Each Chairman is requested to follow the applicable basic outline in preparing the outline for the chapter assigned to his Committee.

The Handbook Committee will continue to meet regularly to coordinate and advance the work. To keep Chairmen informed and alert, there will be sent to them after each Handbook Committee meeting a memorandum of actions taken, of progress made, deadlines to meet and of other items intended to excite and maintain a healthy interest and rivalry.

Reference and Educational Books

Welding Metallurgy, by Drs. Henry and Claussen, is undergoing revision. It is expected that the second edition will be available before the end of this year.

Foreign Libraries (O. B. J. Fraser, Chairman, Special Committee)

The Special Committee on Handling Requests for Foreign Libraries was only called upon to act in two cases during the year. The Bureau D'Etudes et de Recherches Scientifiques of Bruxelles, Belgium, pointed out that their library was destroyed during the war, and asked the Society if it could furnish them with a complimentary copy of the *Handbook*, or at a reduced price. The Committee decided to send a complimentary copy of the *Handbook* to the Library.

The second request came from the Germanistic Society of America, Inc. This Society endeavors to continue subscriptions of the periodicals to Germany and Austria. The efforts of this organization are to continue until the German and Austrian libraries are able to take care of the subscriptions themselves. A similar activity was initiated after the last war. This organization requested the A.W.S. to cooperate by allowing them a 20% discount on all subscriptions to The Welding Journal placed by this organization. After careful consideration, the Committee voted to recommend that the Society grant the request of this organization and this recommendation was approved by the Executive Committee of the Society.

National Meetings and Expositions (E. V. David, Chairman)

1946 Annual Meeting and Exposition—The 1946 Annual Meeting of the Society was held in Atlantic City, N. J., in conjunction with the National Metal Congress and Exposition, during the week of Nov. 17–22. This meeting was the first one of full scale and length since the war. All former social activities were restored to the program. The President's Reception on Sunday afternoon and the Annual Dinner on Thursday evening both were outstanding and well-attended affairs. The program of Ladies' Entertainment throughout the week also proved very popular and successful.

The Technical Program included some 24 sessions, at which a total of approximately 80 papers were presented. These papers pertained to such subjects as welding research, resistance welding, cutting, pressure welding, weldability, railroad applications, electrodes, production welding, pressure vessels, storage tanks, machinery, shipbuilding, aircraft, structural welding, hard-facing and high alloys. An important feature was the Adams Lecture, delivered on Monday evening by Dr. Wendell F. Hess. The Ambassador Hotel served as headquarters for A.W.S. and all Technical Sessions were held there.

Due to the unusually large number of papers, the presentation of Medals and Prizes was shifted to the Annual Dinner. The Samuel Wylie Miller Memorial Medal went to James F. Lincoln, of The Lincoln Electric Co., and the Lincoln Gold Medal to H. E. Kennedy, of Berkeley, Calif. Prizes consisted of those sponsored by A.W.S. in conjunction with Resistance Welder Manufacturers' Association. The A. F. Davis Undergraduate Welding Awards also were made at this time.

The National Metal Exposition was held in the Municipal Auditorium at Atlantic City. Approximately 400 firms, representing every phase in the production, fabrication and use of metals and in serving the metal industry, displayed their products. The welding industry was well represented by exhibits of approximately 50 firms in this field. Nearly 4 acres of space, on both floors of the Auditorium, were occupied by the displays. A.W.S. had a booth at the Exposition.

The above represents a considerable amount of effort and time in planning and carrying out of details in putting on a Meeting of this size, on the part of officers and members of the Convention, Program, Publicity, Manufacturers and Philadelphia Section Committees, as well as on the part of A.W.S. staff members. Meetings of these committees begin early in January and continue until the completion of the Meeting.

1947 Annual Meeting and Exposition.—The 1947 Annual Meeting of the Society is scheduled to be held in Chicago, Ill., during the week of Oct. 19–24. The Sherman Hotel has been selected as A.W.S. headquarters since it is well equipped to take good care of our requirements. The Meeting will be again of normal size and scope and all of the regular social activities will be included.

An excellent Technical Program has been prepared. There will be a large number of Technical Sessions, with a group of interesting and timely papers to be presented at each one. All Technical Sessions are to be held at the Sherman Hotel. Many of the papers will be published in The Welding Journal in advance of the Meeting.

The National Metal Exposition will be held at the International Amphitheatre. This year it will be extended to 7 days, Oct. 18–24. On Oct. 18–19, the Exposition will be open to industry in general. Following these two days, the Exposition will run for five days on a restricted basis. Attendance will be confined to executives and engineers who are members of a Technical Society, or who are invited by the exhibitors themselves. A.W.S. will not have a booth at this Exposition.

1946 Pacific Coast District Meeting and Exposition.—The Pacific Coast District meeting, held in conjunction with the Western Metal Congress and Exposition, in Oakland, Calif., the week of Mar. 22, 1947, was a great success. Six technical sessions were held on Monday through Thursday morning, at which 12 papers were presented. The highlight of the Meeting was a luncheon tendered by the San Francisco Section in celebration of its 25th anniversary. C. S. Smith, an early Chairman of the Section, presided. Addresses were delivered by the President of the San Francisco Chamber of Commerce and by President Delhi, whose talk on "The Future of Welding in the West" was well received. Mr. Delhi also presented the Lincoln Gold Medal to H. E. Kennedy, Berkeley, Calif., who was selected as the 1946 winner of the Medal for his paper on "Some Causes of Brittle Failures in Welded Mild Steel Structures." Many of

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After initial adjustments have been made, all components of the welder are operated (through a control panel built into the set) by means of a simple foot-treadle switch supplied with the welder. This switch enables the operator to start or stop the current to the electrode holder—purge air from the gas hose and electrode nozzle prior to welding—change electrodes or electrode adjustment, when necessary, without current to the electrode holder and without entirely shutting down the machine. Use of the foot-treadle switch also permits gas and water to flow in order to let the hot tungsten electrode cool off without oxidizing. An automatic crater filler is optional.

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the past officers of the Section were present, as were also the District Vice-President and some of the National Officers of the Society. A session of Section officials, with representatives of the National Society, was also held during the Meeting.

Welding was well represented in the Exposition which had a record attendance of 91,022. For the first time, the Exposition was open on Saturday and Sunday and it proved so helpful to those unable to attend during the week, that it has been decided this year to open the National Metal Exposition on Saturday and Sunday.

Credit is due the San Francisco Section officers and members, the District Vice-President and the President of the Society, for this successful Meeting.

Separate Welding Exposition (O. B. J. Fraser, Acting Chairman)

In the absence of H. W. Pierce, Chairman of the Special Committee, O. B. J. Fraser, a member of the Special Committee, reported that a meeting of the Committee with representatives of R.W.-M.A., I.A.A., Manufacturers Committee and N.E.M.A. Welding Committee, was held on July 24th in Philadelphia. All organizations were represented excepting N.E.M.A. and the Manufacturers Committee. Due to the relatively short notice of the meeting, Mr. Reddie, designated representative of the absent groups, could not attend. The purpose of the meeting was a study of arrangements with the National Metal Exposition, propositions of exhibit agencies and other arrangements that might occur to this group, toward the end of offering recommendations to the A.W.S. Board of Directors.

The matter was fully discussed, which resulted in inability to bring in a report unanimously approved. The I.A.A. is unalterably opposed to such a venture, the R.W.M.A. is holding in favor of a Separate Show, while unofficially, it is understood that N.E.M.A. is ready to vote for and support such a proposition.

Letters explaining position taken by I.A.A. representatives, and another from the Chairman of the Manufacturers Committee, expressing his viewpoint, were studied by the Committee. As a result of its studies, the Special Committee recommended that the Board of Directors decide between the two following alternatives: (*a*) hold a separate show depending upon the assured support only of R.W.M.A. and N.E.M.A., or (*b*) seek a stronger position in and larger returns to A.W.S. from the present setup with the National Metal Exposition.

Having accomplished its purpose, the Committee requested its discharge. Action taken by the Board is recorded under Board of Directors.

Program Committee (E. Vom Steeg, Chairman)

In connection with the Annual Meeting program of last year, the Program Committee received a considerable amount of criticism based upon the following points: (1) that there were too many papers; (2) some of the papers were not up to the desirable standards of the Society; (3) the crowded condition of the program rendered it difficult for people to see the exhibits. There were other minor criticisms but these were based largely on misinformation.

As a result of this criticism, the National Program Committee has arranged a program for the coming year in Chicago, which differs from programs of previous years in the following respects. Monday afternoon is left free from technical sessions, in addition to Thursday afternoon. No technical sessions are scheduled for Tuesday and Wednesday evenings. Afternoon sessions are limited to three papers instead of four papers. The Program Committee has attempted to enforce some rather simple rules to eliminate, if possible, some of the poorer quality papers. It is quite problematical as to whether or not poor papers can be completely eliminated from an Annual Meeting program, without, at the same time, excluding some of the best papers. The percentage of poor papers has always been exceedingly small and certainly no greater than those prevailing in other technical and professional societies. It is planned to review every paper before actual presentation at the meeting. This requirement may force exclusion of some papers at the very last minute.

The Award of Medals and Prizes has been combined at the Monday evening session at the time of the presentation of the Adams Lecture. Altogether there are 20 technical sessions, covering every phase of welding and application, and covering such subjects as distortion, inspection, railroad welding, refrigerator equipment, pressure vessels, tank, production, research, pipe, maintenance, resistance, ship structures, nonferrous, alloy steels, design, structural, inert gas and the welding of dissimilar metals, as well as, a session on cutting. Altogether there are approximately 60 technical papers scheduled.

Manufacturers Committee (J. B. Tinnon, Chairman)

The Manufacturers Committee met in Atlantic City during the 1946 Annual Meeting and discussed generally the affairs of the Society as they affected the manufacturers. Attention was focused particularly on quality of the Annual Meeting program and the feasibility of holding a separate welding show sponsored by A.W.S. The views of the Committee in regard to the Annual Meeting program were transmitted, through the Chairman, to the Program Committee and, where possible, changes have been made to take advantage of the suggestions. One of primary importance is the shortening of the technical program to allow a greater amount of time for visits to the Show. Some improvement has been made and further will be made in the arrangement of technical sessions.

At the instigation of the Manufacturers Committee, a thorough investigation has been made by a special committee appointed by the Directors, to determine the feasibility of the Society sponsoring an independent welding exposition. The findings of this committee are recorded elsewhere in this report.

Publicity (T. C. Fetherston, Chairman)

Most of the Publicity Committee's work has been concerned with publicizing the Annual Meetings and in attempting to obtain a greater news circulation of Society happenings of special interest to the technical and industrial fields.

Annual Meeting.—The Committee prepared releases for newspapers and the trade and technical magazines prior to the 1946 Annual Meeting and printed a handy attractive folder for the membership, that listed the events and program for that Meeting. It prepared and had mimeographed the abstracts of all Annual Meeting papers that were made available to the Committee for that purpose. Announcements with photographs of the new officers, prize winners and those receiving awards, were sent out to newspapers and the trade press. A similar publicity program is being carried out for the 1947 Annual Meeting, although some changes will be made to keep production costs within the estimated budget.

Special Releases.—The Committee has prepared bi-monthly summaries of the Society's activities for the British Institute of Welding. Material for these releases has been furnished mainly by The Welding Journal, Welding Research Council and the Technical Secretary, although other items of interest are included. The summaries are for use in the published proceedings of the Institute.

Membership Activities.—For distribution to all Sections, the Committee prepared a summary of the methods used by a few of the Sections in their successful attempts to increase the membership.

Western Metal Congress.—Although the Committee sent out a release on the Society meeting at Oakland, Calif., the credit for the publicity on this meeting belongs to the West Coast committee that did such an admirable job in publicizing the meeting. The cooperation given by the welding industry to that meeting was especially helpful and should be continued on a national basis.

Welding Research Council.—The Committee did not function to publicize the work of the Council because of a time delay in getting the report. The Committee believes that certain work of the Council may be of national interest and have news value and, therefore, an attempt will be made to give publicity coverage to the report at the time of its release. Other technical and scientific societies get publicity on research accomplishments and, if suitable, some of the welding research should be brought to the attention of the public without making sensational claims.

Code of Ethics (E. H. Ewertz, Chairman)

Inasmuch as the Committee has had no requests for investigations of any matter coming under its jurisdiction, it has nothing to report at this time.

Awards (D. H. Corey, Chairman)

The Committee on Awards has three specific assignments: (1) the selection of

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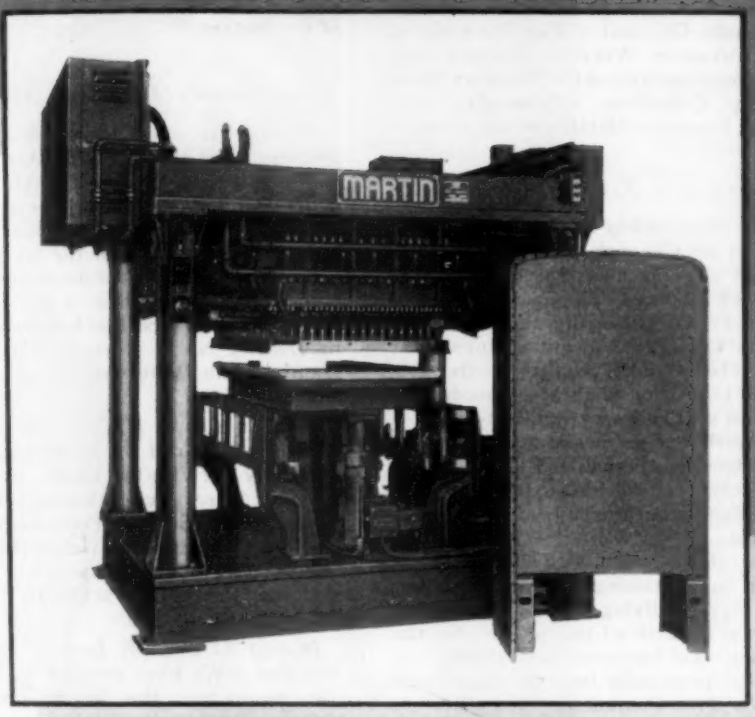

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the recipient of the Samuel Wylie Miller Memorial Award; (2) the selection, subject to confirmation by the Board of Directors, of a candidate to deliver the Adams Lecture, and an alternate; (3) the selection of the winner of the Lincoln Gold Medal Award.

1. Samuel Wylie Miller Memorial Award.—A medal and certificate are awarded annually "to the person who in the judgment of the Committee on Awards is most deserving for conspicuous contributions to the advancement of the welding or cutting of metals" (1947 Year Book). The recipient of the 1946 award, to be presented at the 1947 Annual Meeting, is Dr. Augustus B. Kinzel.

2. Adams Lecture.—The activities of the Committee in selecting the 1948 Adams Lecturer, honoring the Founder and First President of the SOCIETY, were as follows: Choice as Lecturer, Dr. G. E. Claussen; Choice as Alternate, Prof. Wilbur M. Wilson. Both selections were confirmed by the Board of Directors, and Dr. Claussen accepted the invitation to be the 1948 Lecturer.

3. Lincoln Gold Medal Award.—A medal and certificate are awarded annually "to the author of the paper which in the judgment of the Board of Awards is the greatest original contribution to the advancement and use of welding" (1947 Year Book). The recipients of the 1947 award, to be presented at the 1947 Annual Meeting, are Perry J. Rieppel and Manley W. Mallet for their paper "Arc Atmospheres and Underbead Cracking," published in the November 1946 WELDING JOURNAL.

R.W.M.A. Jury of Award (P. E. Kyle, Chairman)

The Jury of Award of the R.W.M.A. 1947 Prize Contest has selected as this year's winners the following:

Industrial:

1st prize—Julius Heuschkel, Westinghouse Electric Corp., E. Pittsburgh, Pa., for his paper entitled "Some Metallurgical Aspects of Carbon Steel Spot Welding."

2nd prize—D. Bruce Johnston, McPhee and Johnston, New York, N. Y., for his paper entitled "Flash Welding of Concentrated Areas up to 24 Sq. In. in S.A.E. 1020, NE 9440 and NE 8620 Steels."

3rd prize—H. J. Grover and L. R. Jackson, Battelle Memorial Institute, Columbus, Ohio, for their paper "Fatigue Tests on Some Spot-Welded Joints in Aluminum Alloy Sheet Materials."

University:

1st prize—W. F. Hess, T. B. Cameron, D. J. Ashcraft and F. J. Winsor, Rensselaer Polytechnic Institute, Troy, N. Y., for their paper "Optimum Welding Condition and General Characteristics of Spot Welds in Magnesium Alloy Sheet."

2nd prize—R. C. McMaster and F. C. Lindvall, Battelle Memorial Institute and California Institute of Technology, respectively, for their paper "The Interpretation of Radiographs of Spot Welds in Alclad 24 S-T and 75 S-T Aluminum Alloys."

Honorary Members (L. W. Delhi, Chairman)

At the meeting of the Board of Directors held in New York on Sept. 18th, John J. Crowe, Asst. Vice-President, Air Reduction Sales Co., and a Past-President of the AMERICAN WELDING SOCIETY was, on recommendation of the Honorary Membership Committee, unanimously elected an Honorary Member of the SOCIETY.

Membership (G. N. Sieger, Chairman)

The Membership Advisory Committee did not meet as such during the year, although each member was contacted by mail at least once. The Chairman and/or Secretary did personally contact several of the Committee members during the year in behalf of the SOCIETY's activities.

The tabulation of the Membership for the past year indicates that the SOCIETY—membership wise—has gone through "a reconstruction period." By the Secretary's office returns for the recent months of the fiscal year the trend now seems again upward.

The efforts stimulated by President Delhi on Sustaining Membership have been very gratifying. There is an active program on with all the Sections for the stimulation of increased membership.

It has practically been the unanimous opinion of this Committee that an increase in Section membership as such can be accomplished only by the Sections themselves. The National Headquarters and the National Officers can only stimulate the Section officers to an appreciation of the value of membership. There is no single thing that the National Society has not tried in order to stimulate the Section officers.

We look forward to more effective Section membership activity with the addition of an Executive Secretary, one of whose prime duties will be this very task. He is admirably qualified for the position and we look forward to cooperating with him to the benefit of the Sections specifically and to the SOCIETY as a whole.

A gain of 21.2% in new members during the past year was offset by a 26.4% drop in the rolls making a net loss of 5.2%.

Gains and losses in the various classifications in terms of percentages are given below:

	Increase	Decrease	Net Gain	Net Loss
Sustaining Members	16.4	14.2	2.2	..
Full Members	19.6	20.7	...	1.1
Associate Members	21.9	29.5	...	7.6
Student Members	200.0	93.7	106.3	..

The following Sections presented a net percentage gain in membership for the year: Bridgeport, Cincinnati, Columbus, Dayton, Hartford, Inland Empire, Kansas City, Maryland, Michiana, Milwaukee, Northern New York, Northwest, St. Louis, Syracuse, Tulsa and Western New York.

Membership statistics for the year will be published in the Year Book.

Admissions Committee (O. T. Barnett, Chairman)

During the past fiscal year the Committee had two special cases for consideration. One was the application for student membership in which classification his application did not fall because of holding permanent occupation.

The second case was one who was refused membership on the recommendation of the Section.

Section Advisory (F. W. Davis, Chairman)

District No. 1—F. W. Davis, Vice-President.—Of the eleven Sections, seven were visited by the District Vice-President. All Sections appear to be in a fairly healthy condition. There are indications, however, that certain of the Sections do not have membership consistent with their potential—Bridgeport is a striking example. One new Section has been added to District No. 1 when a charter was granted to the Worcester Section in Nov. 1946.

District No. 2—H. W. Pierce, Vice-President.—Four of the six Sections were visited by the Vice-President. In his report, Mr. Pierce advises that in his opinion the Tidewater Section, Portsmouth, Va., should be disbanded. This Section has been inactive for more than a year. Aside from this, the Sections in this District are in a healthy condition.

District No. 3—R. E. Lorentz, Jr., Vice-President.—We have received an incomplete report from this District. According to my records, three of the five Sections have forwarded annual reports and the Vice-President has visited only the local Section. Sections in Birmingham and Atlanta have been inactive, although there is indication both can be reactivated.

District No. 4—G. O. Hoglund, Vice-President.—Of the ten Sections, five were visited by the Vice-President. With the exception of Toledo, all Sections appear to be in excellent condition. It is Mr. Hoglund's belief that Toledo will need to be reorganized.

District No. 5—R. E. McFarland, Vice-President.—Of the seven Sections, the Vice-President reports visiting three. He has, however, submitted a detailed report of the activities of the District, which not only gives a very clear picture of progress, but also makes mention of unusual activities which have been undertaken by certain of the Sections.

According to Mr. McFarland, the Chicago Section has formed a social organization within the Section known as the "Fusioneers." The purpose of this social organization is to form a closer bond and to increase the number of interested and active members. To date it has been very effective in accomplishing this end.

The Northwest Section of Minneapolis has cooperated with the University of Minnesota in conducting a very successful three-day "Institute in Welding."

Milwaukee Section is justified in their enthusiasm about two activities outside of the regular monthly meetings. One of these was an intensive membership drive in which approximately 175 new members

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McKay	A.I.S.I.	McKay	A.I.S.I.
18-8	308	12 Cr	410
25-12	309	16 Cr	430
25-12 Cb	309 Cb	18 Cr	442
25-20	310	28 Cr	446
18-8 Mo	316	2 Cr Mo	None
18-8 Mo Cb	316 Cb	5 Cr Mo	502
18-8 Mo	317	9 Cr Mo	None
15-35	330	15-60	None
18-8 Cb	347	19-9 W Mo	None

McKAY MILD-STEEL ELECTRODES

McKay	A.W.S.	McKay	A.W.S.
21	E4510	16-H	None
3	E4520	117	None
14	E6013	19	None
15	E6010	10	E6013
17	E6012	715	E7010
116	E6012	711	E7011
16	E6020	714	None
18	E6030	716	E7020

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were obtained in ten days. This drive was followed by a no charge social meeting planned to get the new and old members better acquainted with each other. Milwaukee also had a special educational program which was well received as evidenced by the average attendance of about 225. This consisted of a series of five evening lectures at Marquette University on "Welding Metallurgy." The speakers were well-known metallurgists and engineers who covered the fundamentals, ferrous alloys, cast iron and nickel alloys.

In his conclusions Mr. McFarland recommends a study directed either to the revision of the duties and responsibilities of District Vice-Presidents, or else to improve the setup in the Sections to the end that information be more freely given to the District Vice-Presidents and the New York headquarters.

District No. 6—H. N. Simms, Vice-President.—Of the seven Sections, five were visited by the Vice-President. When Mr. Simms made his report on July 16th, Section reports from Oklahoma City, St. Louis and Tulsa had not been received. Therefore, the report of the district was incomplete.

Mr. Simms noted, however, that arrangements for holding a District officers' meeting in Tulsa were under discussion and it was believed that this meeting would be scheduled in the near future. The object of the meeting was to establish contact between the Sections, as well as to discuss programs for the 1947–48 season.

District No. 7—C. P. Sander, Vice-President.—There are eight Sections in this District but the Vice-President did not report on the number of visitations. The District Executive Committee held a meeting in San Francisco in March, at the time of the Western Metal Congress. According to Mr. Sander's report, the Sections are generally healthy with the exception of Tacoma and Hawaii. Due to inactivity and unsuccessful efforts to reactivate the Section, recommendation has been made that the Tacoma Section be disbanded. Efforts are being made to reorganize the Section in Hawaii. This endeavor, which is being conducted by mail, will necessitate some time for accomplishment.

The officers of the various Sections in this District have gone on record as being favorable to the rotation of the District Vice-Presidency, so that all Sections may in turn have this direct representation. It is the feeling of the Chairman of the Section Advisory Committee that this is a good suggestion. Although I believe that many Districts in the past have tried unofficially to accomplish similar results, it seems to me that a general open agreement between the Sections that this arrangement should be followed would tend to eliminate friction.

Education (P. E. Kyle, Chairman)

Two meetings have been held, one at the Annual Convention at Atlantic City, Nov. 21, 1946, and the other at the Engineering Societies Building in New York, on Mar. 18, 1947. Other business has been done by correspondence.

A Chairman of a Subcommittee to study the problem of what help and stimulation can be given young boys in high schools and trade schools to become successful in the welding industry was appointed. An attempt is being made to survey the needs of this group and then take the necessary steps to carry out an effective program. The members of Mr. Stitt's committee are A. D. Althouse, Supervisor of Vocational Training, Detroit Public Schools; T. B. Jefferson, *The Welding Engineer*, (Editor); C. H. Turnquist, Dept. Head, Veterans' Institute, Detroit; and L. E. Wagner, Asst. Prof. of Metal Processing, University of Michigan. This subcommittee had one meeting on June 9th and plans to meet again at the October Annual Meeting of A.W.S. Consideration is being given to the preparation of a recommended practice in welding training including bibliographies for all of the various subjects covered. The subcommittee recommends that additions be made to its membership to represent other large industrial areas.

The A. F. Davis Undergraduate Welding Awartl Program for 1945–46 was completed. The winners were: first, Joseph S. Ward, Jr., and Stephen Mikochik, of Manhattan College, and second, Lee M. Ragsdale, of Duke University. The closing date of the contest for 1946–47 was changed to Apr. 10, 1947, in order to enable the Committee to announce the winners before the end of the school year so that some publicity can be given the contest on the campus.

The winners of the 1946–47 A. F. Davis Undergraduate Welding Award Program were: first, John W. Price, "Atomic-Hydrogen Arc Welding" and the Rose Technic, of Rose Polytechnic Institute, and second, Howard J. Sanders, "Welders in Diving Suits" and the Cornell Engineer, of Cornell University. The cash awards were presented at Rose Polytechnic Institute by J. R. Stitt and those at Cornell University by Prof. P. E. Kyle. The certificates of award are being prepared and will be presented at the Annual Meeting in October.

One mailing of the announcements for the 1947–48 A. F. Davis Undergraduate Welding Award program has been sent to all engineering schools and this will be followed by another mailing in September.

The survey of welding instruction in engineering colleges and universities is progressing and details of the questionnaire were developed at the March meeting of the Committee.

The work on book reviews is going on as a continuing project, and a revised list of educational movies will be issued soon. A survey is also being made of the welding content of the standard handbooks such as Marks, Kents, etc., and also the new A.S.-M.E. *Metals Engineering Handbook* now in preparation.

Members of the Committee are being encouraged to participate in the meetings of the American Society for Engineering Education, and Prof. Wyant expects to present a paper discussing laboratory equipment requirements in the teaching of welding.

The Committee discussed letter of Dec. 23, 1946, from headquarters regarding Student Chapters. It was the feeling of the group that everything should be done to encourage the formation of such chapters where they have some assurance of success, but that in general, it should not be expected that many such chapters will be formed. Help from local Sections will be needed on this project.

Legislation (H. F. Reinhard, Chairman, Public Relations Committee)

Since no questions were submitted to the Public Relations Committee during the fiscal year, there is no activities report to be made, except to observe that the fact that there were no problems that required attention by the Public Relations Committee is very encouraging.

As far as the personnel of the Committee is concerned, it is my opinion that all interests of the AMERICAN WELDING SOCIETY are well represented, that the personnel are without exception men who stand high in the councils of the interest they represent and that all have sound views as regards matters that properly come to the Public Relations Committee for consideration.

Constitution and By-Laws (H. M. Priest, Chairman)

The following amendments of the By-Laws were submitted and approved by the Board of Directors:

Article II, Section 2. Honorary Members.—"...Honorary Members shall be elected *at a regular meeting* of the Board by the unanimous vote of the members *present*, except that no member of the Board of Directors shall vote upon his own admission."

Article XII, Section 7. Nominating Committee.—"A Nominating Committee consisting of seven members. The Committee shall consist of a Chairman, who shall be a Past-President of the SOCIETY, *and who may or may not be a member of the Board of Directors*, and six members (not members of the Board). Announcement of the appointment and personnel of the Committee...."

Article V, Section 6. Requirements of an Active Section.—"No Section shall be considered active unless it holds at least three meetings during a *fiscal* year...."

By-Laws for the following Sections were approved: Columbus, Ohio; Long Beach, Calif.; Peoria, Ill.; Washington, D. C.; Western Massachusetts; Worcester, Mass.

Report on Technical Activities and Welding Research Council will be published in the December issue of THE WELDING JOURNAL.